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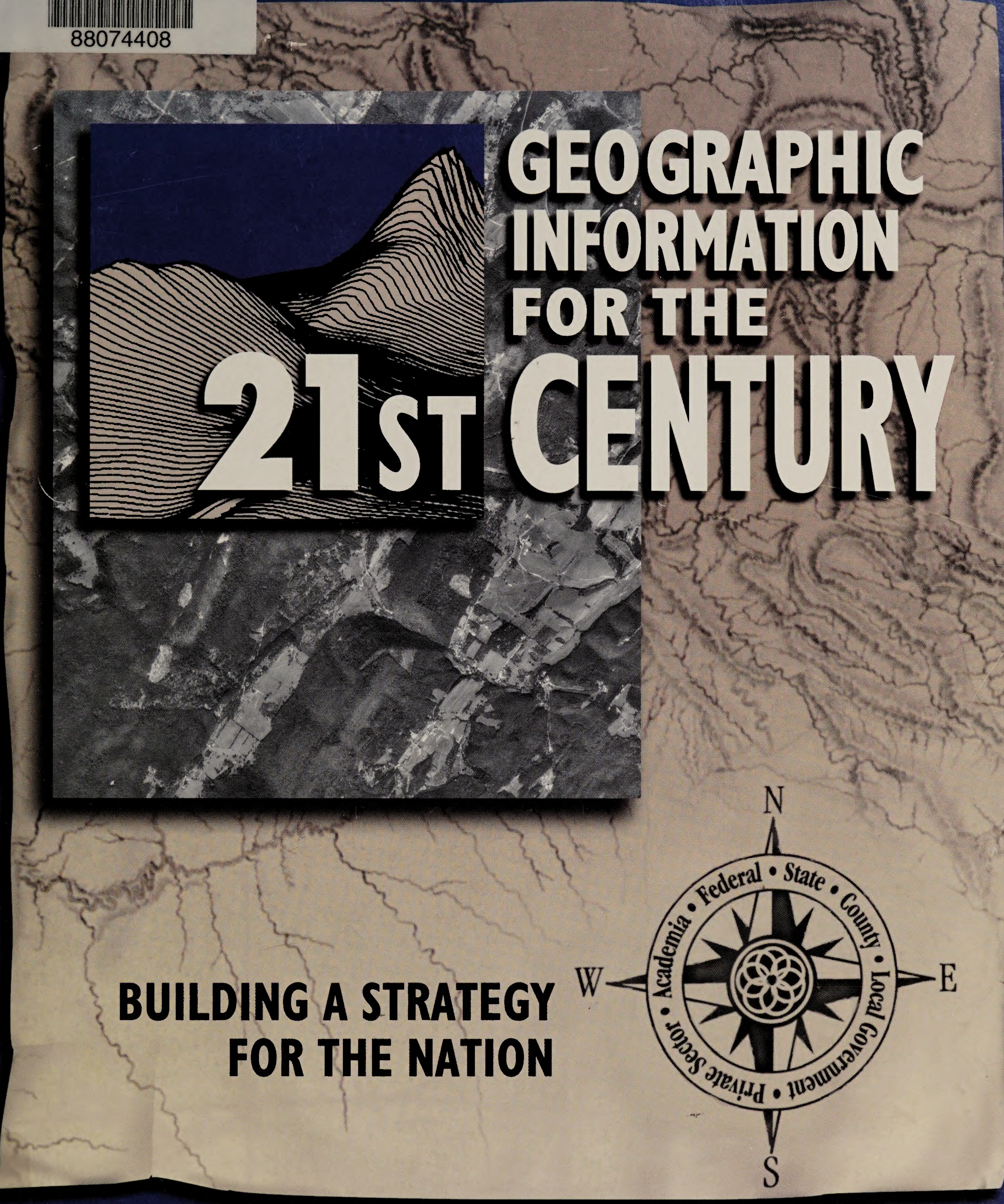
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GEOGRAPHIC INFORMATION FOR THE 21ST CENTURY

BUILDING A STRATEGY FOR THE NATION

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A Report by a Panel of the

NATIONAL ACADEMY OF
PUBLIC ADMINISTRATION

for the Bureau of Land Management,
Forest Service, United States
Geological Survey, and National
Ocean Service

JANUARY 1998

Geographic Information for the 21st Century: Building a Strategy for the Nation

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FOREWORD

The U.S. government has played instrumental roles in surveying, mapping, and other geographic information functions since the beginning of the Republic. These roles have changed significantly over the years as the country moved from an era of exploration and expansion to one in which government is expected to help ensure public safety, manage the public lands for multiple uses, preserve the nation's resources for future generations, and help meet the basic needs of an expanding economy.

While studies have been performed of geographic information technology-related issues in recent years, no one in the past quarter century has addressed comprehensively the public management aspects. In the summer of 1995, conversations began between the National Academy and the American Congress on Surveying and Mapping about undertaking a broad study of U.S. geographic information resources in and outside of government. Calls in Congress to abolish four cabinet departments and hundreds of federal programs stimulated interest in a dispassionate and non-partisan assessment of the significance of spatial data to the economy, the allocation of responsibilities to different levels of government and the private sector, and opportunities for further consolidation of spatial data-related functions in the federal government. The profound impacts of the information technology revolution and the Clinton Administration's support for further development of a National Spatial Data Infrastructure (NSDI) provided additional impetus for the study.

This report, prepared under the supervision of a distinguished panel of Academy Fellows and outside experts, addresses broadly these issues of public management in the context of the nation's total needs for geographic information and how they can best be met. It draws on the work of other organizations, extensive contacts with officials in all levels of government and leaders in the private sector, and a two-day conference designed to tap the knowledge and ideas of experts in the field.

The Panel endorses vigorous development of the NSDI. It urges creation of a national forum to address geographic information policy issues, limited consolidation of federal agencies responsible for the most basic foundation layers of spatial data, reliance on the private sector's burgeoning capabilities to produce and disseminate spatial data, and further expansion of partnership arrangements to advance the concept of shared responsibility for spatial data development and dissemination. At the same time, the Panel endorses current federal policy for maintaining open, low-cost access to spatial data generated by or for governments.

The Panel found that there are many technological challenges to realizing the full promise of a robust NSDI, but the greatest challenges now appear to be on the human side. The technology makes it possible to provide remarkable new capacities for governments and the American people and to do many things more efficiently, but implementation requires significant changes in human relationships and behaviors as well. We hope the recommendations of the Panel help point the way to meeting these challenges.

The Academy thanks the American Congress on Surveying and Mapping and the four federal agencies who sponsored this study – the Bureau of Land Management, the Forest Service, the U.S. Geological Survey, and the National Ocean Service – for providing the opportunity to undertake this work. Many people at all levels of government, the private sector, and academia devoted countless hours providing information, insights, and ideas to the Panel and project team for which we are most grateful. Special thanks also go to the busy people who served on the Panel and the staff who performed the work. The report has benefited from these many contributions.

R. Scott Fosler

R. Scott Fosler
President

EXECUTIVE SUMMARY

The Bureau of Land Management (BLM), on behalf of itself and the U.S. Geological Survey (USGS), the Forest Service, and the National Ocean Service (NOS), asked the National Academy of Public Administration (the Academy) to undertake a formal study of civilian federal surveying and mapping activities. The American Congress on Surveying and Mapping (ACSM) had served as the catalyst for the study, suggested a potential role for the Academy, and formulated an initial list of the major topics to be addressed. Officials from the four sponsoring agencies determined that trends in the larger geospatial arena required a revisiting of how their agencies and how other federal agencies, provide surveying, mapping, and other geographic information (GI) services.*

The project was undertaken partly in response to the fiscal-year 1996 House Appropriations Committee report language that urged USGS to work within the Department of the Interior (DOI) to identify options for consolidating federal mapping functions at the department and to work with the Office of Management and Budget (OMB) on consolidating these functions governmentwide. OMB led a Federal Mapping Task Force study in 1973 that considered management alternatives and advocated greater consolidation of federal GI functions. Additionally, the trend toward devolution of government programs to state and local governments and the need to address the congressional concerns about the existence, structure, and funding levels for federal surveying and mapping functions precipitated the necessity for more timely information about how current federal GI functions and services can be most effectively structured and managed.

In October 1996, the Academy, in consultation with the sponsoring agencies, appointed a project Panel comprised of Academy Fellows and experts in the GI field. Research and analysis of issues guided the development of the Panel's findings, conclusions, and recommendations, which are presented below, according to the four topical areas the Panel was asked to address. In formulating its recommendations, the Panel considered the issues from a broad, national perspective – one that took account of the needs and resources of all levels of government, academia, the private sector, and the general public.

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* Surveying, mapping, and other geographic information describe the broad field of activities, technologies, and science that include geodesy, land, and cadastral surveying, land records, cartography, charting, remote sensing, photogrammetry, image processing, geographic information systems, and generally the collecting of all geospatial data.

Selected recommendations are presented in this summary, followed by a complete list of recommendations which are contained in Chapters Three through Seven of the full report.

NATIONAL SPATIAL DATA INFRASTRUCTURE (NSDI)

One of the most significant changes since the earlier mapping studies has been the growing acceptance of an NSDI. Members of the "GI community" throughout the country seem naturally attracted to the idea of combining the resources of the various levels of government and the private sector to develop and maintain automated databases of geospatial information. Many believe that data should be made widely available at no cost or at reasonable cost to the user, and that this will satisfy an almost infinite variety of governmental, commercial, and societal needs.

In 1994, the President issued an executive order supporting implementation of an NSDI that he defined as the "*technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data.*" (Emphasis added.) The President assigned to the Federal Geographic Data Committee (FGDC) the task of making this come about.

The scope and dimensions of an NSDI are becoming clearer. In a recent strategy document, the FGDC presented the following vision:

> Current and accurate data will be readily available to contribute locally, nationally, and globally to economic growth, environmental quality and stability, and social progress.

The NSDI policies, standards, and activities emerging under FGDC guidance offer the prospect of providing for far more comprehensive, integrated, and available data than what exists today. The listing below synthesizes the characteristics of an NSDI "ideal."

Toward An NSDI Ideal

- There is a common spatial data foundation organized according to widely accepted layers and scales (or resolution) that is available for the entire area of geographic coverage (parcel, neighborhood, city, county, state, nation, etc.) to which other geospatial data can be easily referenced.
- The foundation data is readily accessible and available at no or little cost from user-friendly and seamless sources to meet public needs and encourage conformance with it by producers of other geospatial data.
- Both foundation and other geospatial data, as required and specified cooperatively by data producers and users, is updated according to commonly accepted standards and measures of quality.

- Thematic and tabular data are also available on terms not incompatible with the foundation data.
- When cost-effective, geospatial data produced by one organization, political jurisdiction, or nation is compatible with similar data produced by other organizations, political jurisdictions or nations.
- Geospatial data can be integrated with many other kinds or sets of data to produce information useful for decisionmakers and the public, when appropriate.
- Responsibility for generating, maintaining, and distributing the data is widely shared by different levels of government and the private sector. Governments take advantage of private-sector capabilities available at reasonable prices rather than maintaining dedicated capabilities.
- The costs of generating, maintaining, and distributing such data are justified in terms of public benefits and/or private gains; overlap and duplication among participating organizations is avoided wherever possible.

Many useful steps have been taken to further an NSDI since 1994. These efforts are helping to transform the "old" GI processes into more comprehensive and integrated sets of policies, standards, and procedures for an NSDI. Nonetheless, the challenges of getting to an NSDI that is fully populated with current, accurate, and readily accessible spatial data are daunting, complex, and time-consuming. Not all policies, standards, and procedures are fully in place; and, in the current era of government frugality, the resources available to further them must come largely from within, not as add-ons. Problems, such as data management, integration and maintenance; gaining adherence to standards; providing easy and widespread access; and protecting privacy and personal property, demand attention and resolution. In addition, technologies already available or on the horizon provide important new opportunities to further an NSDI.

The Panel believes that legislation is needed, but the case for any measure beyond the current executive order still needs to be made. Such a statute, at minimum, should include:

- a list of congressional findings about GI
- a statement of national goals and a definition for NSDI
- a charter for the National Spatial Data Council (see below)
- orders for the consolidation of federal base GI functions
- modifications to existing law to facilitate GI partnerships, cooperative research and development agreements (CRADAs), and private-sector procurements
- amendments or rescissions of current law to modernize and conform existing program authorizations to the NSDI concept.

Recommendation

- **Draft a new statute in cooperation with state and local governments and other organizations to create an NSDI, establish a National Spatial Data Council, and better define federal agency roles and responsibilities for NSDI so as to meet the participating organizations' programmatic needs.**

The Panel's responses to the questions posed by the study sponsors build on this basic recommendation.

STUDY QUESTIONS AND THE PANEL'S RESPONSES

Is GI Acquisition, Analysis, and Distribution Critical to Keeping the United States Competitive in a Global Economy?

What Are the Most Important Uses of This Information on a National Scale?

GI is important to over half of the areas of economic activities discussed in the Panel's study, though the importance of GI systems in the global, national, regional, local, and personal contexts cannot be easily described or summarized. The field is too immature, the tool kits too experimental, and the value too imprecise to make a universal assessment. The measures of benefits provided to decisionmaking about land and resources, and the distribution of costs and benefits among individuals and components of society, are poorly documented.

GI and geographic information systems (GIS) are beginning to change how government does business as the complexity of societal interactions and the ease of data manipulation increases. It is neither possible nor necessary to measure and/or assess on a personal or global scale the importance of each or all these activities. The information age now makes it possible and desirable to do many things with geospatial data that were previously impossible and to gain new insights on a variety of public policy issues. While the ultimate value and importance of GI is not in doubt because of the wide range and significance of the economic areas it impacts, measuring and verifying it is an evolving process.

The U.S. economy is in a highly advantageous competitive position internationally and is well-situated to export the information-rich tools its strong commercial GI industry has developed. U.S. companies are recognized as worldwide leaders in the development and marketing of GI capabilities and products. The United States is a leader in establishing standards vital to integrating both data and analysis, and its representatives have a lead role in helping to structure international standards that are both compatible with U.S. technology and consistent with U.S. GI approaches. The United States is also in the lead in developing a clearinghouse for GI. In the world economy, the United States is believed to dominate the GI market, and it has served as the model for more recent GI initiatives in the European Community and Japan. Although many countries are adapting the growing kit of GI tools in the context of their own national political structures and economic approaches, U.S. leadership is likely to continue as long as the U.S. government and industry build on current progress and create a robust NSDI.

What Is the Appropriate Role, Given Recent Technological and Sociological Trends, of the Federal Government in Civilian Surveying, Mapping, and Other GI?

What Functions Are Largely Federal, as Contrasted with Those That Are More Appropriately Administered by State and Local Governments, the Private Sector, or Academe?

The Panel identified 12 major public purposes of the federal government – such as property rights and voting, agriculture and natural resource development, and emergency management – that now rely on GI, and showed how they relate to several common types of GI that the federal government collects. Some of these purposes are pursued directly by the federal government (management of the public lands and nautical charting, for example), while others are pursued in partnership with state and local governments through federal aid and federal regulatory programs (transportation, for example). Some, like ecosystem management, are equally applicable to federal agencies and to state and local governments. Some also apply to the private sector (agriculture, transportation, property rights, environmental protection, for example).

The following three roles in providing GI seem most appropriate for the federal government:

- ensure GI availability to support federal policymaking and operational responsibilities
- ensure that federally-imposed GI requirements on state, local, and tribal governments are reasonably attainable and consistent
- help improve GI data quality and accessibility to benefit an expanding array of users through standards, a national clearinghouse, data archiving, and basic geoscience support.

Recommendations

- **In order to help achieve the geography-related public purposes of federal, state, local, and tribal governments, and public utilities more effectively and efficiently, the federal government should ensure full and rapid implementation of the NSDI in a cost-effective and cooperative manner.**
- **Interagency, intergovernmental, and private-sector GI users and producer groups, whose cooperation is essential to implementing NSDI, should continue to be convened to encourage and accelerate the development, sharing, and maintenance of NSDI framework data files. These groups should be used to negotiate additional data sharing and joint funding agreements.**
- **The potential for using geographically referenced data from government and private transactions to maintain nationwide GI databases should be exploited whenever appropriate and cost-effective to ensure that the most current information is incorporated into the NSDI.**

If Some Functions Are Deemed Suitable to Be Commercialized, Privatized, or Transferred to Nonfederal Governments, What Would Be the Effectiveness and Economic Impact of Those Transfers?

Governmental Functions: The Panel is convinced that the division between inherently governmental and private-sector activities is changing, will continue to shift, and is best settled by consensus rather than reliance on predetermined or philosophical judgments. In many cases, governments will continue to have a legitimate interest in ensuring availability of GI through wide public access. In those activities that involve government liability for the data, as in the case of nautical and aeronautical charts and forest maps, the government should exercise greater control. But more and more the private sector will want very similar data for commercial or business geographic reasons and may make it available at a price to governments. There is no reason to attempt to preclude appropriate resolution and accommodation by preemptively narrowing the role of either. The lack of a clearly defined division between governmental and private-sector roles is not unique to GI – economic data, societal trends, and information generally are not neatly parceled. This may result in some temporary uncertainties, and even some healthy duplication and competition, between the sectors.

The public purposes served by GI are extensive and fundamental to a broad range of governmental activities. However, the GI functions that need to be retained as "inherently governmental" are limited. The government's technological skills and contract-monitoring capabilities will need to be carefully maintained in the face of a growing and highly dynamic private sector.

Devolution Options: The Panel examined several candidate GI activities for possible devolution to state or local jurisdictions, including public land records, base cartographic mapping, and the production of digital orthophotoquads. The long-standing federal Public Land Survey System (PLSS) complements state, local and private land records, but devolution would impose a heavy burden, particularly on Western states, where federal land is a greater percentage of the total land mass and where issues of land ownership and encroachment are common. Similarly, states and local governments have interests in base cartographic mapping and some have substantial capacity, but the fiscal and technical capacity of many states and localities are limited. Most of the goals of an NSDI have required, and will continue to require, intergovernmental coordination and cooperation, as opposed to unilateral product responsibility, and it would not be prudent to recklessly devolve substantial major land record, base cartographic, or orthophoto production responsibilities to state and local governments.

Candidates for Privatization: The Panel considered several GI activities as possible candidates for privatization during its deliberations. These included current governmental recreation mapping in which almost all federal landholders service recreational land use by the public in federally owned parks, forests, wilderness areas, flood-control projects, and hydroelectric sites; production of so-called digital raster graphics (DRGs), currently almost completely outsourced; and street mapping, which is increasingly being privately compiled to support automated automobile navigation systems. There are clear cost advantages to privatizing some or all of these activities, or at least relying on the private sector to produce many of these products, even if market incentives are inadequate to provide uniform nationwide coverage. Nonetheless, the Panel noted that there are potential liability and quality-assurance difficulties that would need to be addressed and felt it was premature to endorse specific GI activities as candidates for privatization. But private-sector capabilities and market interests are growing rapidly, and the Panel is confident that governments and the private sector can, and should, find the means to accommodate their common purposes and interests.

Outsourcing: In the mixed, public-private economy of the United States, there are constant shifts among four sectors: pure government, government enterprises, government purchases from the private sector, and commercial enterprise. There is no single right answer to the question of which public purposes should be met within any given sector. Times change, and the answers change with the times. All four sectors are used to meet public needs. At any given moment, the Constitution and the laws enacted by

Congress provide the answer to what should be the proper balance among the four sectors, or an array of options that may be used.

Partnerships: Multilateral partnering and consortiums are more likely to build the form of intergovernmental coordination and private-sector cooperation that the NSDI requires. Increasingly, consortiums, rather than bilateral partnering, are needed to meet the mutual geospatial data needs of multiple users and provide a means to promote cooperation and data-sharing. The GI capabilities of states and localities need to be strengthened. Empowering their GI groups, adopting and implementing national standards, promoting greater linkages with counties, cities, and other local jurisdictions would greatly improve the ability of states and localities to build the NSDI. Federal agencies and the FGDC, for their part, need to coordinate their demands on state and local GI groups, support state and local programs responsive to their data needs, and encourage greater awareness and understanding of the value and utility of the NSDI, including FGDC standards, clearinghouse functions, and partnership efforts.

Pricing and Intellectual Property Rights: Federal data and pricing policies often conflict with state and local government and private-sector interests in generating revenue, a situation that is likely to be exacerbated as more data is digitized and becomes available on line. These practices constrain partnering to the mutual disadvantage of all sectors.

Recommendations

- **GI resource managers should increasingly emphasize multilateral partnerships — interagency, inter-governmental, and with the private sector — to promote a robust NSDI and as a source of savings. Broad consortiums that involve multiple governmental levels and engage the private sector should be favored, and USGS's unique authority to engage in innovative partnerships should be extended to other agencies.**
- **Multilateral partnering, including CRADA-type partnering with the private sector on agency operational activities, should be increased. Government agencies should avoid engaging in value-added activities beyond the R&D phase when they can be provided by the private sector at or near government cost.**
- **Outsourcing decisions should be made on the basis of the respective roles, responsibilities, and competencies of the governmental and private sectors. Cost- effectiveness is one of several factors that need to be considered. On the other hand, arbitrary percentage targets for contracting out should be avoided.**
- **The federal government policy of promoting open access, especially for all data used in public policy decisionmaking, should be maintained and the states and localities should be urged to adopt similar policies.**
- **The federal government, possibly under the lead of the FGDC, should articulate a clear policy or draft legislation that allows the government to work cooperatively with the private sector to protect private-sector intellectual property rights for GI, particularly uniquely private and value-added data sets.**

Are There Opportunities to Consolidate or Otherwise Restructure Federal Surveying, Mapping, and Other GI Functions to Achieve Greater Economy and Performance?

If So, Which Functions Should Be Brought Together and How Should They Be Structured?

While the FGDC has been instrumental in much of the progress achieved over the past few years, the Panel is convinced that an organization is needed which provides full participation by all the major parties and interests engaged in developing and maintaining the NSDI.

After considering options in both the public and private sectors, the Panel believes the best of both can be provided by a new private, nonprofit organization, the National Spatial Data Council (NSDC), which preferably would be authorized in law by Congress but clearly located in the private sector. This new organization's charter and activities would compliment those of the FGDC, which would concentrate much more on coordinating GI functions and activities inside the federal government.

Charter and Mission

- advances national goals for the NSDI, preferably through a new federal law
- provides a forum for bringing together the views of all sectors engaged in developing, maintaining, and using the NSDI
- serves as a link with other public and private-sector organizations engaged in GI-related activities, the National Information Infrastructure (NII), and policy communities using GI
- carries out specific functions assigned to it by law or by its membership

Goals and Objectives

- provide a national forum for developing and maintaining the NSDI
- maintain state-of-the art knowledge about advances in GI and related technologies
- help ensure that goals set for the NSDI are actually carried out in practice by serving as a catalyst for implementation
- build a comprehensive and user-friendly GI clearinghouse using a customer-responsive and businesslike approach
- bring to the table the views on national standards of all interested parties, and possibly assume over time the responsibility now housed in the FGDC for this function
- provide training and education on the utility of and techniques for fostering the NSDI

Recommendations for Immediate Action

- **In order to aid in reconciling conflicts and to monitor agency implementation, designate that the OMB program associate director for natural resources, energy, and science be a full member of the FGDC.**

- **To bring a broader technology perspective to the FGDC, a senior staff member of the Office of Science and Technology Policy also should be a member of the committee.**
- **Until the NSDC is established, increase state, local, and tribal government participation in the FGDC and encourage stronger involvement by the private sector.**
- **Encourage active participation in FGDC by all agencies having major GI-related programs, including NASA and DoD.**
- **Rapidly grow the current FGDC clearinghouse to (1) identify as much geospatial data as possible, including that derived from states, local governments, and the private sector, and (2) evolve toward user-friendly, online data access as technology permits.**

Recommendations for a Long-term Solution

- **Increase awareness of the current and potential value of the NSDI and of the plans to develop it among the public, members of Congress, state legislatures, county commissions, city councils, professional associations, and commercial interests.**
- **Establish through legislation a national goal to create and maintain a robust NSDI.**
- **Create a private, nonprofit NSDC, modeled on the current FGDC and NSDI charters, with appropriate representation by all levels of government and the private sector.**
- **Retain a federal committee with ties to the NSDC to coordinate federal GI under the NSDI.**

Consolidating Base Geographic Information Functions into a New Geographic Data Service (GDS)

The current federal structures and practices for GI need not be massively transformed as was recommended in 1973 and 1981, in part because of evolving technology and growing interagency cooperation, but the Panel believes that consolidation of base GI functions could improve efficiency and provide a stronger platform for building the NSDI.

GI functions performed by federal agencies and their present locations are as much an accident of history as they are a logical choice to meet today's and tomorrow's GI needs. For example, geodetic referencing emerged as part of the Coast and Geodetic Survey because of its affiliation with requirements for nautical charting, even though geodesy relates more to the land mass and precise positioning on land than coastal or ocean navigation. Similarly, aeronautical charting evolved in the same organization because of its charting expertise, not its affiliation in any way with aeronautics.

If creating a robust NSDI and achieving much greater spatial data sharing across agency boundaries, political jurisdictions, and the public and private sectors are the goals, then the Panel believes it is essential to achieve "critical mass" by bringing together most of the fundamental components that are responsible for the basic GI functions of the federal government. These goals are enormously ambitious, and efforts to achieve them require a strong mandate and solid support. Good intentions, consensus, and technology alone will not fulfill these goals, only provide the base for promising but modest first steps. The new GDS, along with a legislatively mandated policy base, an NSDC, an FGDC refocused on federal GI activities, and stronger partnerships with key state, local, and private-sector participants are all necessary to meet the goals.

The mission of this new organization would encompass that of all the agencies transferred into it, but the whole should literally be more than the sum of its parts. Therefore its mission should be to:

> Support the full development of the National Spatial Data Infrastructure and ensure that U.S. economic, governmental, and societal needs for geographic information and services are met in cooperation with all levels of government and the private sector.

The new organization, the specifics of which would be designed by a federal task force under OMB leadership, could include BLM's cadastral survey and land records functions, the National Mapping Division (NMD) from USGS, surveyors and possibly some of the geometronics functions of the Forest Service, and the National Geodetic Survey from NOS. Nautical charting is also shown as part of this new organization. The Panel favors including it, but there may be reasons for leaving it in Commerce or transferring it to the Department of Transportation (DOT). A Remote Sensing Services Division would be created and include NMD's Advanced Systems Center, the EROS Data Center, and responsibility for the Civil Applications Committee. Its job would be to facilitate civil access to remote-sensing products and services of both the public and private sectors.

Capacity-sharing among federal agencies and with state and local governments for development of the NSDI requires a strong field presence and coordinated efforts among federal agencies in dealing with the states. Unfortunately, current federal field office jurisdictional boundaries and their divergent geographic locations, some of which do not conform to state boundaries, make the process of coordination difficult and complex. Some agencies have established state coordinators for their programs, but there is no one charged with interacting with state, local, and tribal governments on a broad base of GI functions. Had the ten standard federal regions of the 1970s survived, the problem might not be as complex, but the tendency in recent years has been for agencies to tailor their field structures to meet program needs and facilitate interaction with local, state and regional counterparts.

The service's new field structure would be state-based to link more directly with state GI coordinating groups and to local and tribal government GIS capabilities in those states. State liaisons could be patterned after the NGS geodetic advisers and made responsible for coordinating with federal program officials having GI-related responsibilities. One approach would be to establish 20–25 GI centers. Each center would be responsible for a variety of GDS programs. In this way, each could ensure that the different data efforts correspond to each other, both in terms of data accuracy and programmatically.

Recommendations for Immediate Action

- **Forward to Congress legislation to transfer the National Geodetic Survey (NGS) to USGS and to authorize the establishment of a Geographic Data**

Service (GDS) contingent upon submission of a reorganization plan prepared by a task force mandated by OMB.

- **Consider creating a performance-based organization in DOI for federal surveying and land-title records activities.**

Recommendations for the Longer Term

- **Develop a reorganization plan in cooperation with the NSDC to implement the GDS and realign the federal field structure for base GI.**

Using the Results Act As a Tool for Coordination

Several aspects of current federal surveying, mapping, and other GI activities could be improved through modification to existing management processes and procedures. Among these is the establishment of strategic plans for each agency with explicit ties to agency performance measures and results, as required by the Government Performance and Results Act. Currently, separate agency strategic plans and performance measures are not being integrated. Similarly, the success of the National Aerial Photography Program that consolidates a large portion of mapping-quality aircraft imagery could serve as a model for the emerging world of commercial satellite imaging and remote-sensing capabilities. Finally, the Panel took note of the success of combining of federal agencies' global change research into a single program; no comparable effort to consolidate and streamline surveying, mapping and GI research exists in the GI area.

Recommendations

- **Develop coordinated goals, strategies, performance measures, and budgets for federal agency GI programs and activities. Explicitly establish selected strategic goals and performance measures, as required by the Results Act, to help move the NSDI toward further and faster realization.**
- **USGS, or the GDS when established, should be tasked to coordinate federal acquisition of imagery for civil government purposes from aerial platforms, and classified intelligence, civil domestic, foreign, and commercial satellites.**
- **The FGDC should act as the focal point for coordinating the high priority GI technology needs of civil government at all levels and for mobilizing interagency, state, and local support for selective high-payoff technology developments with utility in multiple civil applications.**

Domestic-National Security Relations

Coordination between the domestic and national security components of the federal sector could also be improved. While coordination of product production and dissemination are reasonably good, other aspects of GI coordination between these sectors could be improved. More active participation by NIMA and NASA in the work of the FGDC is needed, and a new policy-level committee involving both civil and national security agency heads would be influential in promoting better coordination.

Recommendations

- **NIMA should become much more actively engaged in the FGDC because of the increasing need to coordinate GI activities, including technological**

research, standards, security policy, procurement practices, and international activities.

- **A policy-level committee that includes the secretary of interior, the directors of NIMA and the National Reconnaissance Office, a representative of the director of central intelligence, and other appropriate representatives should be established to focus on policies needed to foster greater civil use of classified imagery.**
- **The Civil Applications Committee (CAC), supported by the USGS's Advanced Systems Center, should become the technical and implementing arm of this committee.**

Agencies' Views and Comments

The sponsoring organizations were provided a draft of this report for review and comment. Their responses varied in terms of their support for the Panel's recommendations. Generally, agencies who would lose components or whose responsibilities would be diminished by the proposed structural changes opposed those changes. Other concerns were expressed about the adverse effects of the proposed changes on related program missions. Copies of the organizations' policy comments are provided in Appendix J of the full report.

COMPLETE LIST OF RECOMMENDATIONS

CHAPTER 3 — GEOGRAPHY-BASED PUBLIC PURPOSES AND GI ROLES

Recommendations

- In order to help achieve the geography-related public purposes of the federal, state, local, and tribal governments, and public utilities outlined in this chapter, more effectively and efficiently, the federal government should help to ensure full and rapid implementation of the National Spatial Data Infrastructure (NSDI) in a cost-effective and cooperative manner.
- Interagency, and intergovernmental and private-sector GI user and producer groups, whose cooperation is essential to implementing NSDI, should continue to be convened to accelerated development, sharing, and maintaining of the NSDI framework data files. These groups should be used to negotiate additional data sharing and joint funding agreements. These groups and agreements should address the following key success factors of NSDI: (a) reliable geodetic referencing of data, (b) adequate content and format standards, (c) acquisition of commonly used and widely accepted data in compatible digital forms, and (d) the continuing capacity, expertise, skill, and engagement of public agencies necessary for them to ensure the quality of data from multiple sources.
- The potential for using geographic-referenced data from government and private transactions to maintain nationwide GI databases should be exploited, whenever appropriate and cost-effective, to ensure that the most current information is incorporated into the NSDI.
- Interagency and intergovernmental consortiums should be encouraged to become increasingly important providers of geospatial data to the NSDI, following national standards.
- The federal government should support long-term, interdisciplinary research by universities and others on GI technologies, earth sciences, and related

topics, consistent with encouraging private sector initiatives. Priorities for such research should include, but not be limited to programs to develop: (1) practical generalization software to translate between scales; (2) techniques for utilizing satellite imagery to enable rapid updating of GI data files and maximum analytical use of this new source of massive amounts of GI without overwhelming the system; (3) easy-to-use automated techniques for updating base data with current transaction data; and (4) software for merging and harmonizing geographic data files from diverse sources.

CHAPTER 4 — PROVIDING NATIONAL LEADERSHIP AND COORDINATION FOR THE NSDI

Federal Geographic Data Committee (FGDC)

Recommendations for Immediate Action

- In order to aid in reconciling conflicts and to monitor agency implementation, designate the OMB program associate director for natural resources, energy, and science to be a full member of the FGDC.
- To bring a broader technology perspective to the FGDC, a senior staff member of the Office of Science and Technology Policy also should be a member of the committee.

Recommendations for Interim Action

- Further increase state, local, and tribal government participation in the FGDC and encourage stronger involvement by the private sector.
- Encourage active participation in FGDC by all agencies having major GI-related programs, including NASA and DoD.
- Rapidly grow the current FGDC clearinghouse to (1) identify as much geospatial data as possible, including state, local and private sector data, and (2) evolve toward user-friendly, on-line data access as technology permits.

The Need for a New Public-Private Organization – The National Spatial Data Council (NSDC)

Recommendations for a Long-term Solution

- Increase congressional, state legislature, county commission, city council, professional association, commercial, and public awareness of the NSDI's current and potential value, and current plans and strategies to develop it.
- Establish through legislation a national goal to create and maintain a robust NSDI.
- Create a private, nonprofit NSDC, modeled on the current FGDC and NSDI charters, with appropriate representation by all levels of government and the private sector.
- Retain FGDC, with ties to the NSDC, to coordinate federal GI under the NSDI.

Using the Results Act (GPRA) As a Tool for Coordination

Recommendation for Immediate Action

- Develop coordinated goals, strategies, performance measures and budgets for federal agency GI programs and activities. Explicitly establish selected strategic goals and performance measures, as required by the Results Act, to help move the NSDI toward further and faster realization.

Standard-Setting Processes for U.S. Geographic Information

Recommendations for Immediate Action

- Concentrate FGDC standard-setting activities on data content standards for the framework layers.
- Increase staff support for FGDC secretariat functions and dedicate staff in each agency for standards development, implementation, compliance, and outreach, especially to federal field offices.
- Develop performance measures for agency development and compliance with FGDC standards.
- Improve structural coordination of framework activities and the FGDC standard-setting process.
- Make use of on-going initiatives, such as land-use planning for public lands and ecosystem management, as drivers to strengthen state/local support for common standards.
- Establish a FGDC presence on the IISP.
- Provide for stronger FGDC-NIMA coordination on international standards.

Recommendation for the Longer Term

- Standards that are national in scope should be coordinated by the NSDC. FGDC would represent the federal viewpoint in this council.

State and Local Government Coordination Initiatives

Recommendations

- Designate states as major nonfederal FGDC partners and encourage development of a strategy for all states to have greater commonality of GI capacity and infrastructure.
- Re-examine the FGDC framework layers in the context of state and local GI needs as well as federal needs.

Relationship of the NSDI to the National Information Infrastructure and the Information Technology Community

Recommendations for Immediate Action

- Get federal GI more actively integrated into the administration's NII initiatives and vice versa.
- Federal agencies need to incorporate GI and GIS and the NSDI concept into their overall information technology strategies and plans.

CHAPTER 5 — POLICY BASES, STRUCTURE, AND ORGANIZATION TO MEET TODAY'S AND TOMORROW'S GI CHALLENGES AND OPPORTUNITIES

Building the Policy Base Around a New National Commitment to the NSDI

Recommendation

- The administration should develop a new statute in cooperation with state and local governments and other organizations to create an NSDI, establish a National Spatial Data Council, and better define federal agency roles and responsibilities for NSDI so as to meet the participating organizations' programmatic needs.

Base Geographic Functions and the Need for a New Geographic Data Service

Recommendations for Immediate Action

- Forward to Congress legislation to transfer NGS to USGS and authorize the establishment of a GDS contingent upon submission of the reorganization plan prepared by a task force mandated by OMB.
- Consider creating a performance-based organization within DOI for federal surveying and land title records activities.

Recommendations for the Longer Term

- Develop a reorganization plan, in cooperation with the NSDC, to implement the GDS and realign the federal field structure for base GI.
- Consider transferring responsibility for TIGER file maintenance, after the 2000 census, to GDS.

CHAPTER 6 — BALANCING THE ROLES AND FUNCTIONS OF THE GOVERNMENTAL AND PRIVATE SECTORS

Assessing the Devolution Option

Recommendations

- No specific federal GI functions should be devolved at this time.
- State and local governments should establish GI coordinating groups or focal points responsible for serving as the points of contact responsible for NSDI coordination and cooperation.

Evaluating Privatization Alternatives

Recommendation

- Government agencies should avoid engaging in value-added activities beyond the research and development phase when they can be provided by the private sector at or near government cost.

Contracting Out or Outsourcing Options

Recommendations

- USGS, or the GDS recommended in Chapter Five, should be tasked to coordinate federal acquisition of imagery for civil government purposes from aerial platforms and classified intelligence, civil domestic, foreign, and commercial satellites.
- The USGS-led Civil Applications Committee should take the lead in interaction with the intelligence community and with international and commercial providers on civil governmental needs and encourage the greater utilization of these data.
- Federal agencies should lead and encourage other levels of government to be involved in remote-sensing activities through example and partnering,
- Outsourcing decisions should be made on the basis of the respective roles, responsibilities, and competencies of the governmental and private sectors.
- Cost-effectiveness is one of several factors that needs to be considered; on the other hand, arbitrary percentage targets for contracting out should be avoided.

Advancing Partnerships and Capacity Sharing

Recommendations

- GI resource managers should increasingly emphasize multilateral partnerships – interagency, inter-governmental, and with the private sector – both to promote a robust NSDI and as a source of savings.
- USGS's unique authority to engage in innovative partnerships should be extended to other agencies.
- Multilateral partnering, including CRADA-type partnering with the private sector on agency operational activities, should be increased.

Impact of Pricing Policies and Intellectual Property Rights

Recommendations

- The federal government policy of promoting open access, especially for all data used in public policy decisionmaking, should be maintained and states and localities are urged to adopt similar policies.
- The federal government, possibly under the lead of the FGDC, should articulate a clear policy or draft legislation that allows the government to work cooperatively with the private sector to protect private-sector intellectual property rights for GI, particularly private and value-added GI data sets.

CHAPTER 7 — OTHER ISSUES

GI Technology Research and Development

Recommendations

- The technology development programs of civil agencies involved in GI should focus on civil government applications and basic science support. Federal government agencies should utilize, and not attempt to compete with, private-sector leadership in many areas of technology development applicable to GI.

- NIMA and NASA should ensure that FGDC members are made fully cognizant of technological developments applicable to civil government needs. To further civil government applications, the technology development programs of NIMA, the National Reconnaissance Office, and NASA should be coordinated and undertaken jointly, whenever possible, with civil agencies.
- The FGDC should act as the focal point for coordinating the high-priority GI technology needs of civil government at all levels and for mobilizing interagency, state, and local support for selective high-payoff technology developments with utility in multiple civil applications.

Domestic-National Security Relations

Recommendations

- NIMA should become much more actively engaged in the FGDC because of the increasing need to coordinate GI activities, including technological research, standards, security policy, procurement practices, and international activities.
- A policy-level committee that includes the secretary of the interior, the directors of NIMA and the National Reconnaissance Office, a representative of the director of central intelligence, and other appropriate representatives should be established to focus on policies needed to foster greater civil use of classified imagery.
- The CAC, supported by USGS's Advanced Systems Center, should become the technical and implementing arm of this committee.

CHAPTER 1

Origins of the Study and Research Methodology

On September 30, 1996, the Bureau of Land Management (BLM), on behalf of itself and the U.S. Geological Survey (USGS), the Forest Service, and the National Ocean Service (NOS), asked the National Academy of Public Administration (the Academy) to undertake a formal study of civilian federal surveying and mapping activities. The American Congress on Surveying and Mapping (ACSM), which had served as the catalyst for the study, suggested a potential role for the Academy and formulated an initial list of the major topics to be addressed. Officials from the four sponsoring agencies determined that trends in the larger geospatial arena required a revisiting of how their agencies and how other federal agencies, provide surveying, mapping, and other geographic information (GI) services.*

The project was undertaken partly in response to the fiscal-year 1996 House Appropriations Committee report language that urged USGS to work within the Department of the Interior (DOI) to identify options for consolidating federal mapping functions at the department and to work with the Office of Management and Budget (OMB) on consolidating these functions governmentwide. OMB led a Federal Mapping Task Force study in 1973 that considered management alternatives and advocated greater consolidation of federal GI functions. The issue was revisited by a panel of the National Research Council (NRC) in 1981. Additional GI-related studies also had been conducted by the NRC's Mapping Science Committee (MSC) in the 1990s. ACSM and sponsoring agency efforts identified the need for updating the task force study and NRC studies in light of advances in surveying and mapping technologies. Additionally, the trend toward devolution of government programs to state and local governments and the need to address the congressional concerns about the existence, structure, and funding levels for federal surveying and mapping functions precipitated the necessity for more timely information about how current federal GI functions and services can be most effectively structured and managed.

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* Surveying, mapping, and other geographic information describe the broad field of activities, technologies, and science that include geodesy, land, and cadastral surveying, land records, cartography, charting, remote sensing, photogrammetry, image processing, geographic information systems, and generally the collecting of all geospatial data.

STUDY TOPICS

The Academy was asked to address four topical areas:

- Is geographic information acquisition, analysis, and distribution critical to keeping the United States competitive in a global economy? What are the most important uses of this information on a national scale? (Chapter Two)
- What is the appropriate role, given recent technological and sociological trends, of the federal government in civilian surveying, mapping, and other GI? What functions are largely federal, as contrasted with those that are more appropriately administered by state and local governments, the private sector, or academe? (Chapters Two, Six, and Seven)
- If some functions are deemed suitable to be commercialized, privatized, or transferred to nonfederal governments, what would be the effectiveness and economic impact of those transfers? (Chapter Six)
- Are there opportunities to consolidate or otherwise restructure federal surveying, mapping, and other GI functions to achieve greater economy and performance? If so, which functions should be brought together and how should they be structured? (Chapters Four, Five, Six, and Seven)

In October 1996, the Academy, in consultation with the sponsoring agencies, appointed a project panel comprised of Academy Fellows and experts in the GI field (Appendix A). A project staff also was assembled to undertake the study research and analysis (Appendix A). Following preliminary research and issue identification by the Panel and staff during Phase I of the study, a report was completed for the sponsoring agencies in early 1997 which included the Panel's identification of ten issue areas to be explored in Phase II (Appendix C). These ten issues would answer the questions raised in the four topical areas and guide the development of the Panel's findings and recommendations.

Phase I research and analysis reconfirmed the desirability, timeliness, and usefulness of a comprehensive assessment of federal GI resources. There seemed to be general agreement among the agencies, congressional staff, and professional associations that an updated review of the Federal Mapping Task Force Study was needed. The revolution in GI technologies – the Global Positioning System (GPS), geographic information systems (GIS), computer hardware and software, and the communications interconnectivity fostered by the Internet – have promoted greater interest and significant growth in GI capabilities. There has been a corresponding increase in GI capabilities for land-use planning, management, environmental protection, and emergency management by local, regional, and state governments, in addition to the longstanding GI roles and responsibilities of the Forest Service, BLM, USGS, NOS, and other federal agencies. Further, the rapidly growing capabilities of the commercial remote-sensing and imaging communities to provide masses of data on a comprehensive and repetitive basis serve to force a reexamination of current roles and missions in mapping and related GI functions.

Throughout the study the project staff met with an advisory committee established by the sponsoring agencies that was composed of federal officials and an ACSM representative (Appendix B). The committee's invaluable efforts facilitated the collection of data from the members' respective agencies and provided logistical support for numerous Panel and staff activities. Committee members also were available to discuss and review study priorities, monitor progress, and discuss study methodologies and scheduling with the staff and Panel.

PROJECT METHODOLOGY

The project staff reviewed previous reports on the study topics, including the report of the 1973 OMB-led task force and reports by the National Research Council of the National Academy of Sciences – *Need for a Multi-Purpose Cadastre,* the 1981 *Organizational Review of Federal Surveying and Mapping,* and the 1993 *Toward a Coordinated National Spatial Data Infrastructure.*

Additionally, the Panel and staff received briefings from each of the four sponsoring agencies and reviewed extensive information on their GI activities. The staff also made field visits to all of the four agencies to become familiar with the scope of their activities and the range of their concerns. Other federal agencies with significant GI activities were consulted, including the National Aeronautics and Space Administration (NASA), the Department of Defense (DoD) – the National Imagery and Mapping Agency (NIMA) and the Army Corps of Engineers (ACE) – the Department of Transportation (DOT), and the U.S. Department of Agriculture's (USDA) Natural Resource Conservation Service (NRCS). Additionally, officials of the Bureau of the Census, the Council on Environmental Quality (CEQ), the Federal Geographic Data Committee (FGDC), and OMB, briefed Academy staff on their organizations' GI responsibilities and activities. Project staff also met with professional staff of the House and Senate appropriations committees and the House Resources Subcommittee on Energy and Minerals, as well as with General Accounting Office (GAO) staff.

Background information was reviewed on GI activities of state, local, and tribal governments, and GI activities in the private sector, with particular attention to evolving roles, capabilities, and technological usage. Project staff met with key members of the National States Geographic Information Council (NSGIC) and attended the council's mid-year policy meeting in March 1997. The National Association of Counties (NACo), and the National Association of Regional Councils (NARC), and the National League of Cities (NLC) participated in Academy staff focus groups and were consulted on appropriate governmental and private-sector roles in GI standards-setting, cooperation, and partnerships. The impacts of partnership arrangements for data development, management, integration, and access, as well as pricing practices, were evaluated in the context of the Academy's vision of a coordinated National Spatial Data Infrastructure (NSDI), discussed in Chapter Two.

A wide range of state and local officials were interviewed by mail, by telephone, and in person. In addition to extensive interviews with federal agency representatives based in Washington, D.C., project staff conducted several federal regional, state, and local site visits, which included trips to Alaska, California, Colorado, Maryland, Oregon, South Dakota, Virginia, and the State of Washington. Contact was also made with other leading GI associations, including the Urban and Regional Information Systems Associations (URISA), American Society for Photogrammetry and Remote Sensing (ASPRS), and Automated Mapping/Facilities Management International (AM/FM). A complete listing of all organizations whose representatives met with the project staff is provided in Appendix D.

Project staff also contacted and conducted interviews with representatives of numerous private-sector providers and associations, including the Open GIS Consortium (OGC) and the Management Association of Private Photogrammetric Surveyors (MAPPS). Project staff attended several OGC advisory committee meetings and discussed national GI policy activities with a wide range of private-sector providers and users of GI. Academic researchers on GIS were consulted, including members of the University Consortium on Geographic Information Systems (UCGIS), to determine technological trends and research agendas, as well as their individual views on the study topics.

The ACSM/ASPRS annual conference was used as a forum for Academy staff to brief conference attendees on the issue areas identified for analysis. Participants expressed a variety of views and were encouraged to communicate additional views to the project staff following the conference. Project staff interviewed some attendees and held a round table discussion with surveyors and other selected federal agency officials. Additionally, project staff attended the June 1997 meeting of Intelligent Transportation Systems America (ITS America).

The project staff addressed each of the ten issue areas, beginning with a review of the federal policy bases for current organizations and activities related to GI, and the statutory and administrative charters under which the sponsoring agencies and other relevant federal agencies operate. Information gathered during the briefings, interviews, and field visits, as well as that in written data and reports, was organized into issue analyses which were reviewed by the Panel. Each analysis contained a series of alternative recommendations for consideration by the Panel.

The sponsoring agencies were asked to respond to an Academy data request. The requested information sought detailed financial reporting, including budget obligations by mapping and surveying functions, data on public-private cost comparisons, research and development activities, partnership arrangements, and pricing policies. Additional data was obtained on (1) the cost of federal GI activities, (2) other public mapping and surveying expenditures and revenue generation, and (3) comparative OMB Circular A-76 type cost analyses.

The data collected by OMB in a 1993 review of GI spending was reassessed in the context of the Academy's data call. The 1993 OMB data, which estimated federal spending on geographic data at $4.1 billion in 1993, used a more expansive definition, i.e., "collection and management of geographically referenced data." Three large components were: (1) $1.3 billion for Defense's non-U.S. geographic information activities, (2) $1.1 billion for the Department of Commerce's information that is not primarily GI, such as that on weather, climate, satellite, and fisheries activities, and (3) $0.6 billion in non-geographic mineral, geologic, hydrologic, and other non-geographic information. The spending on GI, based on data provided to the Academy, is estimated at about $1.0 billion in 1998, including obligations by the four sponsoring agencies of about $0.4 billion and by other agencies of an estimated $0.6 billion. The latter includes ACE, USDA's National Resource Conservation Service, and DOI's National Park Service and its Fish and Wildlife Service.

Through an analysis of existing GI functions, the Panel and staff ascertained which specific functions lent themselves to consolidation or cross-servicing using existing and future technologies. The analysis included a determination as to whether the consolidation of defense mapping functions was a model applicable to the civil side of government. The Panel and staff considered why prior recommendations for a single civilian surveying and mapping agency were not implemented and whether conditions have changed sufficiently to warrant reconsidering this proposal. A proposed outline of the components for a comprehensive statute for governmentwide GI functions was the result.

The current strengths and weaknesses of leadership initiatives in pursuit of the NSDI were evaluated as staff attended meetings of the FGDC and of selected subcommittees and task forces of OGC and other organizations. The processes for standard-setting for GI were reviewed. Staff attended meetings of the FGDC Standards Working Group (SWG) and reviewed national and international GI standard-setting bodies, such as the American National Standards Institute and the International Organization for Standardization. Data collection, processing, management, clearinghouse, and maintenance efforts of all parties collecting GI were assessed.

Information was reviewed about the experiences of Great Britain, Canada, and other countries, as well as the experiences of state and local governments in the United States that have copyrighted their maps or otherwise restricted access by charging fees for access to GI databases. The information was analyzed with respect to (1) public revenues generated, (2) the extent to which these revenues have enhanced public mapping programs, (3) relationships with competing private-sector map providers, and (4) the effect of these public activities on the innovativeness and productivity of private firms.

Additionally, several related topics pertaining to the four study question areas were explored and written analyses of them were prepared. These include the economic value of GI activities and their impact on U.S. global competitiveness, and the impact of changing societal values and patterns of governance affecting GI-related activities. Comparative historical and international developments in these areas also were addressed (see Appendices E and F, respectively).

Invitational Conference

Projects like this study of GI resources in the United States benefit from the participation of people who are engaged in the work of helping to solve the problems the study was commissioned to address. Accordingly, the Academy convened a two-day meeting at the Cosmos Club in Washington, D.C., June 27–28, 1997, that was attended by national leaders in the GI field. The attendees discussed current challenges and future considerations for strengthening the nation's GI base. Several Panel members and Academy Fellows attended the meeting, some of whom presided over the afternoon working sessions. A summary of the proceedings was prepared by the project staff and provided to the Panel. See Appendix G for the conference agenda and summary.

Panel Deliberations

Project staff analyses were presented to the Academy Panel during seven meetings held between December 1996 and September 1997. At the first meeting, staff provided the

Panel with background on the genesis of the study and the questions to be answered, extensive information from the sponsoring agencies on the activities to be reviewed, and presentations from other governmental groups with interests in geographic data.

At the second meeting in Salt Lake City, Utah, the Panel heard additional perspectives from national security and private-sector representatives. The Panel assigned priorities to the ten issues and provided guidance to staff for further research and analysis on each issue that was to be conducted during Phase II of the project.

At the third meeting in March 1997, the staff reviewed the progress to date on a number of issues. The Panel reached some preliminary conclusions for possible congressional briefings or testimony and heard the views of senior experts in GI from Canada and the United Kingdom. The Panel and staff met with the NRC's Mapping Science Committee to discuss the committee's visions for GI and the issues being addressed by the Panel.

The fourth and fifth Panel meetings were devoted to additional staff briefings and Panel discussions of the ten issues and analysis of other related issues. The Panel provided guidance on additional research needed and reached decisions on specific options for the staff to pursue in drafting the final report.

At the sixth meeting, the Panel reviewed proposed findings, conclusions, and recommendations prepared by the staff. At its final meeting, the Panel reviewed and approved the proposed final report.

Sponsoring Organizations' Comments

A draft of this report was provided to the sponsoring agencies, the American Congress on Surveying and Mapping, and the FGDC for their review and comments. These organizations were asked to provide both technical and policy comments. The former were reviewed by the project staff, and changes to the text were made, where appropriate. The latter were shared with the Panel, and they are included in Appendix J. Following incorporation of these comments, the report was circulated to the Panel for approval and publication.

ORGANIZATION OF THE REPORT

This report is organized into seven chapters. Following this introductory chapter, Chapter Two describes the Academy Panel's vision for the NSDI. Chapter Three discusses the central role of GI in government services and the need to guarantee access to this information for public purposes. Chapters Four and Five detail current leadership and coordination initiatives in the federal GI community and evaluate structural arrangements that best satisfy agency missions and national GI needs. Appropriate roles and functions of GI providers and users, including a discussion on outsourcing functions, as well as pricing and partnerships for GI, are discussed in Chapter Six. Several ancillary issues that influence GI activities and national policies are brought together in Chapter Seven.

CHAPTER 2

Economic, Technological, and Societal Trends and the Panel's Vision — Where Geographic Information Is Headed

In 1993, the National Research Council's Mapping Science Committee (MSC) pointed to the transformation occurring in the access to data and information and the impact this was having on mapping. Maps in analog form, which had been the mainstay of a wide variety of applications and decisionmaking, were increasingly available in digital form, complemented with additional data that was newly represented geographically.

It correctly concluded that the ease of transport and integration inherent in digital mapping would provide transparent access to myriad databases for countless applications. MSC called this not always coherent and less-than-coordinated emerging entity the "National Spatial Data Infrastructure" (NSDI) and defined it as follows:

> [T]he National Spatial Data Infrastructure is the means to assemble geographic information that describes the arrangement and attributes of features and phenomena of the Earth. The infrastructure includes the materials, technology and people necessary to acquire, process, store, and distribute such information to meet a wide variety of needs.[1]

Actually, FGDC staff noted that the term NSDI was in use in the geospatial community in the late 1980s and possibly before. Drafts of 1990 Circular A-16 revision also used the term, referring to the "eventual development of a national digital spatial information resource," with the involvement of federal, state, and local governments, and the private sector. This national information resource, linked by criteria and standards, was to "enable sharing and efficient transfer of spatial data between users and producers."

OMB, the MSC, and others acknowledged not the creation, but the existence of an ad hoc NSDI. The MSC foresaw the challenge over the next decade as enhancing the accessibility, communication, and use of spatially referenced data supporting all levels of society.

The National Performance Review (NPR) endorsed the views of OMB, the MSC, and others by promoting an NSDI, and Vice President Gore recommended that these enhancements be accelerated.[2] In Executive Order 12906, issued in 1994, the President supported more rapid implementation of an NSDI, which he defined as the "*technology, policies, standards, and human resources* necessary to acquire, process, store, distribute, and improve utilization of geospatial data." (Emphasis added.) The President assigned coordination of the federal government's development of the NSDI to the FGDC, now chaired by Secretary of Interior Bruce Babbitt and with members from almost all of the federal agencies involved in GI.

People throughout the country in what is known as the "GI community" seem naturally attracted to the idea of combining the resources of different levels of government and the private sector to develop and maintain automated databases of geospatial data. Many believe that data should be made widely available at no cost or at reasonable cost to the user, and that this approach will satisfy an almost infinite variety of governmental, commercial, and societal needs.

The executive order defined the NSDI in terms of "policies, procedures, standards, technologies, and people." The NSDI was not regarded as a data set or series of data sets. Since 1994, many useful steps have been taken to further an NSDI:

- The FGDC now has its own budget and personnel and has embarked on an ambitious program of education and outreach, expanding its subcommittee membership to include an increasing array of nonfederal government and private partners, and most recently including nonfederal members on the FGDC steering committee.
- A national data clearinghouse has been established with an ever-expanding number of state, academic, and other nodes; it was designed to provide ready access to data sources in a standard "metadata" format developed by the FGDC.
- In addition to the metadata standard, the FGDC has established new "national" standards for cadastral mapping, data transfer, and wetlands and is nearing completion of similar standards on orthophoto maps, vegetation, elevation, and other digital map prerequisites.
- The FGDC has initiated grant programs to foster GI cooperation among state, regional, and local entities; and to develop base data and to publicize NSDI benefits.
- Federal agencies and many states have now created metadata and World Wide Web sites are increasingly populated, not only with federal data, but with locally and state-generated data sets.
- New cooperative arrangements, workshare agreements, and innovative partnerships have proliferated among the federal, state, and private sectors.
- New cooperative research and development agreements (CRADAs) for cooperative public-private endeavors have been set up by NOS, USGS, U.S. Bureau of the Census, and other agencies.
- The MSC and a concurrent study under FGDC auspices helped to further the NSDI by providing guidance on establishing a framework and, in MSC's case, identification of the most critical framework layers – geodetic control, digital terrain, and digital orthorectified imagery – as well as the important role to be played by data partnerships and consortia. (USGS noted that MSC's three foundation layers and FGDC's seven framework layers are complimentary in concept.)
- The number of states actively involved in GI and in structuring their own state agencies to cooperate in GI committees has grown rapidly, and they are

increasingly engaged in promoting outreach to regional, county, and local governmental levels.

- Major private-sector geographic information hardware and software companies have expanded their capabilities and have coalesced as a consortium to promote interoperability and data sharing.

These efforts are helping to transform the "old" GI processes into more comprehensive and integrated sets of policies, standards, and procedures for an NSDI. Nonetheless, the challenges of getting to an NSDI fully populated with current, accurate, and readily accessible spatial data are daunting, complex, and time-consuming. Not all policies, standards, and procedures are fully in place; and, in the current era of government frugality, the resources available to further them must largely come from within and not as add-ons – necessitating the most efficient use of those resources. Problems, such as data management, integration and maintenance, gaining adherence to standards, providing easy and widespread access, and protecting privacy and personal property demand attention and resolution. In addition, technologies already available or on the horizon provide important new opportunities to further an NSDI.

Before responding to the questions posed by the sponsoring agencies, the panel believes it is essential to provide the reader its vision of an NSDI that is both achievable and valuable to its users. This chapter describes the economic, technological, and societal trends influencing the evolution of GI, summarizes the underlying assumptions the panel used in developing its findings and recommendations, briefly describes the technology impacting NSDI development, and sets forth its vision for further progress on an NSDI.

ECONOMIC, TECHNOLOGICAL, AND SOCIETAL TRENDS

The economic significance of GI and the societal changes influencing its evolution were among the questions posed to the panel by the study sponsors. Discussion of these topics at this point will help set the stage for describing the panel's vision for the NSDI and the appropriate governance structure to help make it a reality. Technological advances are also discussed here because they play such a large part in shaping that vision.

The Economic Value of Geographic Information

Geographic information is a significant subset of the information explosion that has occurred in the last half of the 20th century. GI itself is being transformed rapidly and radically by developments in GIS* hardware and software, commercial imagery and other remote-sensing capabilities, satellite navigation systems, and the Internet. Data presented traditionally in tabular form are now viewed and analyzed with a geographic perspective using sophisticated GIS software. GI systems do not exist in isolation; they stand alongside of and are measurably enhanced by an array of other emerging technologies such as computer-aided design, image processing and manipulation, data compression, three-dimensional modeling, visualization, and simulation. The synergy among hardware, software, and communications technologies magnifies the strength and importance of GI systems today, a trend that is likely to continue into the foreseeable future.

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* A geographic information system (GIS) is a computer-based tool for mapping and analyzing spatial data and events that happen on earth.

The full importance of GI systems within global, national, regional, local, and personal contexts, however, cannot be easily described or summarized. The GIS field is still too immature, the tool kits too experimental, and the value too imprecise to make a universal assessment. The University Consortium of GI Science (UCGIS) recognizes this deficiency, and it has recommended that a high priority be attached to the value and impact of the considerable investment already made in spatial information technologies. It recognizes that the benefits are primarily in the realm of measures of efficiency and financial benefits arising from improved access to information. Little is known or understood about the long-term effects that the products of these technologies will have on the communities and the organizations that implement them. The measures of benefits provided to decisionmaking about land and resources, and the distribution of costs and benefits among individuals and components of society, are poorly documented.

Numerous uses of GI are now evident, including:

- Unprecedented measurement of global climate change and international environmental conditions is possible with these new technologies, including geospatial reference systems; many of the world's concerns with ozone depletion, rain forest protection, and cyclical weather causes and patterns are geographically based.
- Nationally, long-standing concerns with marine and aeronautical navigation, transportation planning, and congressional redistricting stand alongside emerging interests in endangered species; ecology, wetland, and watershed preservation; and forest, rangeland, and soil management. Planning for disaster mitigation and relief are also of growing national significance.
- Regional and state concerns with ecosystems, hydrology, and wildlife habitats are now getting increased attention along with traditional state highway, river, and recreational needs.
- Local demands for modern and efficient land records management, land-use planning and zoning, and public works and utilities management are rivaled by growing interest in GI related to schools, public safety, crime, and community services.
- Private-sector interest in GI for public service and real estate development are buttressed by burgeoning consumer appetites for automobile navigation and GI-based convenience data provided over the Internet.

In most cases, the availability of GI in analytical systems makes it possible for both decisionmakers and the public to consider the various impacts of alternative policy options using timely and interactive visualizations and calculations of alternative futures to better resolve conflict and reach informed consensus.

Measuring the Benefits of GI

Most benefits of GI activities traditionally stemmed from productivity savings. However, GI and GIS are beginning to change how government does business. It is neither possible nor necessary to measure and/or to assess the importance on a personal or global scale of each or all these activities. The information age now makes it possible and desirable to make multiple use of geospatial data in ways that were previously impossible and to gain new insights on a variety of public policy issues. While the ultimate value and importance of GI is not in doubt, effective measuring and verifying the utility of GI is still evolving.

One fact that complicates measuring the economic value of GI is that, in many cases, it is a public good. Generally, information is a public good if furnished by government and, economically, its use by one party does not prevent other parties from using the same information. Geospatial data sets are an "optional" public good: the marginal cost of supplying an additional unit is low but not zero, and individuals can be excluded from using the good or service by limiting their distribution and/or charging a fee for their use. The new electronic technology is making it more difficult to limit access, however, and certain individuals can access the information free of charge by browsing in libraries, indexes, or on view screens.

Table 2-1 cites some of the major sectors of the U.S. economy that are impacted by GI. It is impossible to measure precisely the impact that automated GI has had on these sectors, but their sheer size and importance to the nation's economic well-being is obvious. GI plays a role in about one-half of the economic activities of the United States. Such major economic and industrial sectors as agriculture, transportation, defense, land management, community development, construction, and real estate are dependent to some degree on GI. Clearly, GI has a more significant bearing and influence on some of these sectors than on others. Examples of high-value usage include (1) soils data for agriculture, (2) road networks and cargo tracking for some transportation activities, and (3) localized computer-aided design (CAD) information for construction.

U. S. Competitiveness Internationally

The U.S. economy is in a highly advantageous position to compete internationally and is well situated to export the information-rich tools its strong commercial GI industry has developed. Companies like ESRI, Intergraph, ETAK, MAPINFO, DeLorme, and ERDAS are recognized as worldwide leaders in the development and marketing of GI capabilities and products. The United States is a leader in establishing the metadata, data content, and data exchange standards vital to integrating both data and analysis, and its representatives have a lead role in helping to structure international standards that are both compatible with U.S. technology and consistent with U.S. GI approaches. The United States is also in the lead in developing a clearinghouse for GI.

Spatial data provided by government also contributes to the national economy. For example, accurate navigation data can improve the performance of U.S. ports which, in turn, can help keep U.S. export products competitive in the global economy. One exception to U.S. leadership is in land records where other countries with mandated responsibilities for a national cadastre or states with institutionalized approaches having state and/or private-sector roles that are clearly defined appear to be further advanced.

GI hardware and software exports are estimated to exceed $500 million in 1997. It is difficult, however, to estimate GIS hardware exports, given the increased use of standard PCs in GIS applications, and exports could be more than $1.0 billion. In addition, the worldwide market for GIS is growing rapidly, an estimated 10 to 15 percent annually. In the world economy, the United States is believed to dominate the GI market and it has served as the model for more recent GI initiatives in the European Community and Japan.

TABLE 2-1: PRINCIPAL RELATIONSHIPS BETWEEN GEOGRAPHIC INFORMATION AND THE ECONOMY

Economic Purposes Relying on Geodata	Importance to the National Economy			
	Economic Sector	Size of Sector (est.)	Contribution of Geographic Information	
			GI Product (Input)	Outcome
1. Property Rights and Voting Rights	▪ Real Estate ▪ Elections	$600 billion	▪ Property Records (Historic/Current) ▪ Census Data	More efficient: ▪ Real estate markets ▪ Reapportionment
2. Revenues from Property	▪ Government Revenues	$200 billion	▪ Location/Value of Properties ▪ Location/Amount of Natural Resources ▪ Jurisdictional Boundaries	Enhanced Revenues, with less effort from: ▪ Real estate taxes ▪ Mineral and oil leases ▪ Timber sales ▪ Payments in-lieu-of-taxes
3. Transportation, Navigation, and Commerce	▪ Commuting ▪ Business Travel ▪ Leisure Travel ▪ Freight/ Goods Movement	$600 billion	▪ Planning ▪ Environmental GIS ▪ Construction Designs ▪ Performance Monitoring ▪ Navigation Charts	▪ Less congestion and pollution ▪ More mobility and access ▪ More efficient goods movement/ world trade ▪ Less impact on the natural environment and human settlements ▪ Safer navigation
4. Public Land and Marine Sanctuary Management	▪ Minerals/Oil ▪ Timber/ Grazing ▪ Recreation	$300 billion	▪ Geological Maps ▪ Public Land Surveys ▪ Property Disputes ▪ Ecosystem Management ▪ Recreational Maps	▪ Easier access to land records ▪ Better stewardship of the land ▪ Multiple-purpose management ▪ Improved customer satisfaction
5. Agricultural and Natural Resource Development	▪ Agriculture			
6. Environmental Protection and Ecosystem Management	▪ Environmental Equipment and Services	$200 billion	▪ Wetlands/Habitat ▪ Vegetation ▪ Water ▪ Soils ▪ Pollution Monitoring	▪ Sustainable development

TABLE 2-1 (continued)

Economic Purposes Relying on Geodata	Importance to the National Economy			
	Economic Sector	Size of Sector (est.)	Contribution of Geographic Information	
			GI Product (Input)	Outcome
7. Community and Economic Development (including utilities, housing and public works)	▪ Construction ▪ Homebuilding ▪ Public Works	$600 billion	▪ Demographic/ Economic Analysis ▪ Land Use ▪ Infrastructure Systems	▪ Better Communities ▪ More good job opportunities
8. Emergency Management	▪ Insurance ▪ Emergency Services ▪ Recovery Services	$150 billion	▪ Natural Hazards ▪ Infrastructure ▪ Emergency Operations Facilities ▪ Demographics	▪ Reduced losses from emergencies ▪ Quicker, better recoveries from disasters
9. Public Service Delivery (including health, education, social, criminal justice, etc.)	▪ Public Sector ▪ Nonprofit Sector ▪ Private Contractors	$628 billion	▪ Demographics ▪ Service Facilities Locations ▪ Case Locations ▪ Infrastructure	▪ More effective and efficient public services
10. National Defense	▪ Defense Establishment	$270 billion	▪ Navigation Charts ▪ Current Imaging ▪ Field Operations Maps ▪ Transportation Facilities	▪ Domestic GI products that meet U.S. military and anti-terrorist needs
11. Earth System Sciences and GI Technologies	▪ Government Research Labs	>$10 billion	▪ Better Science ▪ Better Earth-measurement Technologies	▪ Understand the Earth better ▪ Better geographic information

Source: Compiled by Academy staff from multiple federal agency briefings and documents, and from other sources.

Although many countries are adapting the growing kit of GI tools in the context of their own national political structures and economic approaches, U.S. leadership is likely to continue as long as the U.S. government and industry build on current progress and create a robust NSDI.

The Impact of Technological Advances

Surveying and mapping functions have been performed for centuries. Customs, methods, and practices in these professions evolved over long periods of time. It is only in the last several decades that changes in technology with which almost everyone is now familiar – the computer, mass communications media, and aerial photography – and some not so familiar – satellite navigation systems, geographic information systems and software, and remote sensing – have opened the door to fundamentally new ways of performing these age-old tasks and much broader public access to the data generated. They have also made possible new ways of organizing these tasks, drawing on the resources of all levels of government and the private sector.

A recent book[3] identified four key technologies as having major impacts on GI: satellite navigation systems, remote-sensing imagery, geographic information systems, and the Internet. Not only have these technologies dramatically changed the ways and forms in which GI is created, maintained, disseminated, and used; they have also changed the practices of the national mapping organizations of many industrialized nations. Each of these technologies provide major new opportunities, but they also pose new challenges or problems in using them. The four technologies are discussed briefly below.

Satellite Navigation Systems

Both the United States and Russia now operate satellite navigation systems (the U.S. constellation is called the Global Positioning System (GPS)) which can enable anyone with the proper receiver to determine fairly precisely and in three dimensions – latitude, longitude, and altitude – where they are anywhere on the earth. With the aid of differential stations or the post-processing of data, such determinations can be made within a centimeter or two of true location, thus opening a whole new array of approaches to address age-old challenges of determining location. Their impact on surveying, for example, is described as follows:

> The ability to observe satellites from anywhere on the earth . . .changes the way in which survey has been performed for two centuries or more. Instead of control points being on the ground, they are in the sky – but the principles are the same. The traditional way of setting fixed ground control points treated each as the vertex of one or more triangles, from each of which the angle to at least two others was measured, together with the length of at least one side of one triangle. . . . From this network, or web, the position of all control points was calculated in relation to all others and more detailed mapping of features (such as rivers and roads) was collected and positioned based on this knowledge. Such fixed control points were often indicated by monuments.[4]

GPS technology not only removes the need for many control points in the field, it enables almost anyone to perform technical field functions normally done by licensed land surveyors. In addition, surveys requiring these special skills can be performed in the field with crews of half the size or less of those using traditional equipment. GPS enables precise positions to be determined quickly and cheaply. (The Forest Service pointed out that GPS users need to fully understand what they are doing and its impacts. GPS is only a measuring device and it will not replace expertise and knowledge to evaluate corner evidence, survey evidence, and collect collateral and collaborative survey evidence to support land surveys.)

There are numerous other uses for GPS, many of which are GI-related, and the markets for GPS-related products are growing rapidly. These are detailed in an earlier Academy report, *The Global Positioning System: Charting the Future.*[5]

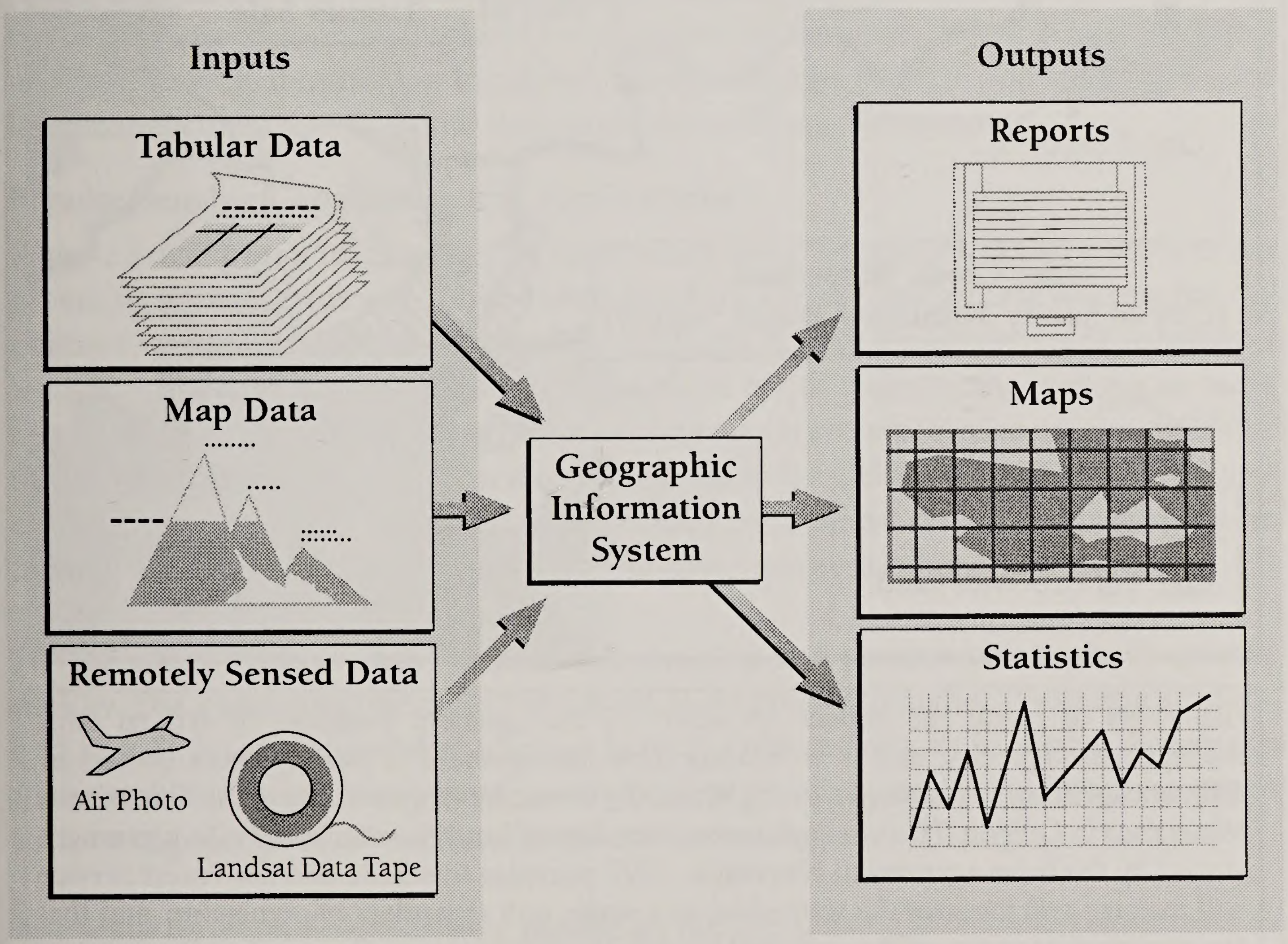
Geographic Information Systems

GIS technology integrates common database operations, such as query and statistical analysis, with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable for a wide range of public and private enterprises for the purposes of explaining events, predicting outcomes, and planning strategies.[6]

Figure 2-1 shows how GIS can integrate data from satellite imagery, satellite navigation systems, and mapping and tabular data to produce maps, statistics, and other reports.

FIGURE 2-1: GEOGRAPHIC INFORMATION SYSTEM (GIS)

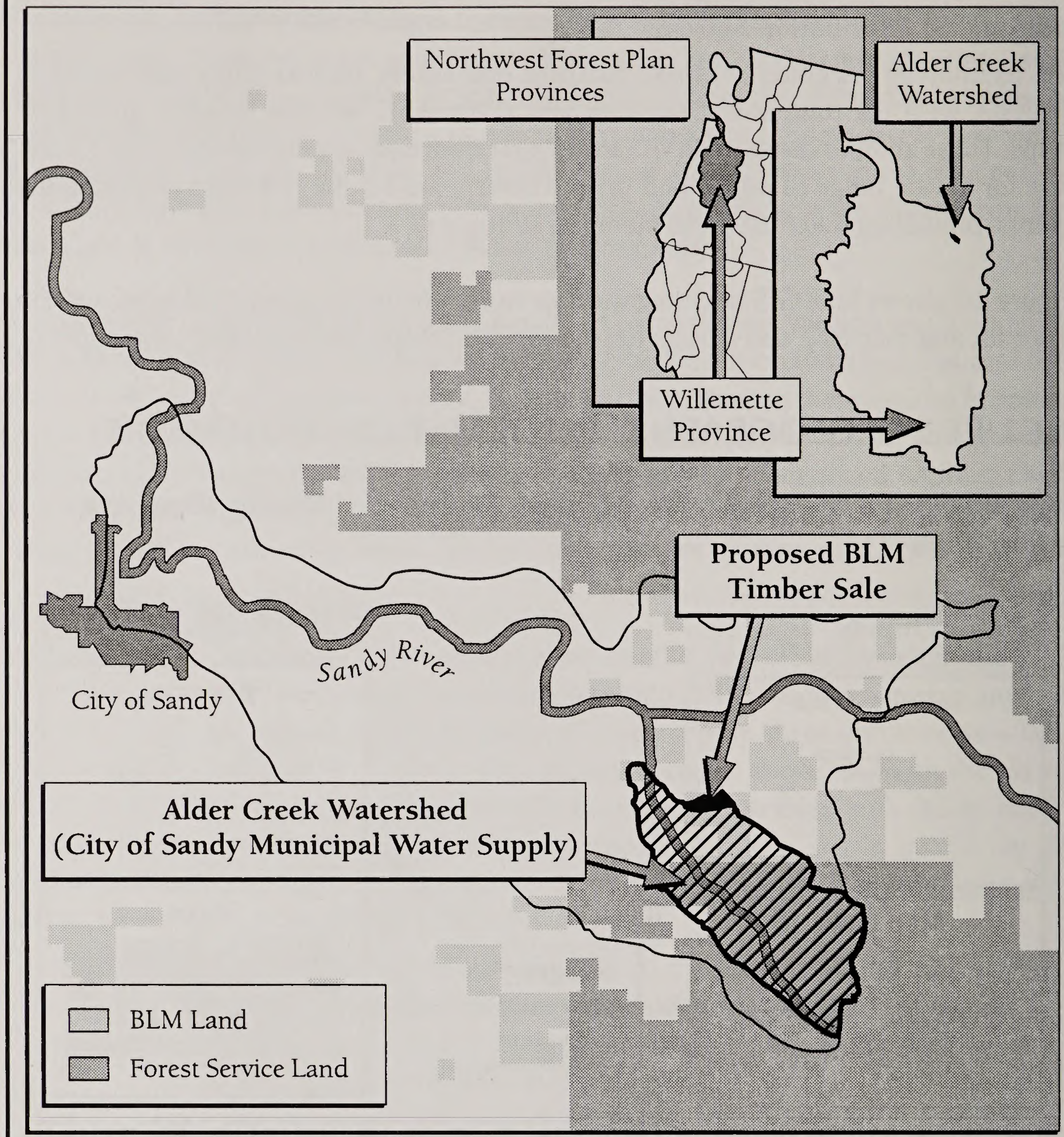
An Automated System to Create, Manage, Analyze and Display Geographic Information



A GIS stores information about the world as a collection of thematic layers that can be linked together by geography. This has proven quite valuable for solving many real-world problems, from tracking delivery vehicles, to recording details of planning applications, to modeling global atmospheric circulation. GIS technology is especially useful for analyzing geographic data for patterns and trends, and to compare "what if" scenarios.

Because governments have responsibilities such as land management, disaster response, and environmental protection which require GI and its analysis, GIS units

FIGURE 2-2: FEDERAL LANDS IMPACT LOCALITIES: SANDY, OREGON



GIS helps to reveal the impact on others of management practices by federal land management agencies, and is facilitating joint management of nearby lands owned by different agencies. For example, the BLM and the Forest Service own land in the Alder Creek Watershed in Oregon. This is a key source of the City of Sandy's water supply. An agreement signed by the three agencies in November 1997 provides that BLM and the Forest Service will manage and monitor the watershed as a single unit regardless of ownership, and that the quality of its water will be sufficient for drinking in the future. Geographic data and GIS will also be used to ensure compliance with this agreement over time. Management practices, direct impacts, cumulative effects, and water quality will be measured, monitored and reported to decisionmakers and the public with the assistance of GIS.

Source: Bureau of Land Management, Oregon State Office, J. S. Nihbert.

have proliferated in government organizations, small and large, at all levels. These GIS units have enabled the compilation and analysis of data in ways that were not possible before, but they have also resulted in the creation of thousands of databases, many of which have been customized to meet specific user needs and thus are not readily usable by others or capable of being easily combined with other databases containing similar data. And, as the number of databases grow and become established, the job of conforming the data to common standards and assuring they are interchangeable becomes even more difficult.

The trend in GIS, however, is migration from complex, stand-alone systems operated by specialists to a broader information environment containing spatial components which provide decision support on every desktop, communicate information in a geographic context, and offer spatial data availability to a broad range of users over the Internet and within the intranets of individual organizations. Spatial data becomes embedded in data sets containing a wide variety of tabular and other data responsive to end-user needs.

Moreover, GIS is increasingly institutionalized as part of organizations' business processes, particularly in efforts to reengineer governments and maximize the effectiveness of information technology. For example, as shown in Figure 2-2, GIS is being used to measure, monitor, and report to decisionmakers and the public about federal land management practices and their impacts on local governments.

Remote Sensing Capabilities and Applications

Remote sensing and imaging satellite capabilities in the United States and elsewhere are providing growing sources of huge quantities of GI. The success of these systems has significantly contributed to knowledge of the earth and provided ever-increasing volumes of land information. But the contributions of these major systems are evolving to more recent technological advances in remote sensing which are expected to continue into the future. Other advanced collection technologies as well as advances in digital image processing/photogrammetry, coupled with the other commercial, off-the-shelf capacities are moving production responsiveness from the government to commercial sources.

Private-sector investment in commercial imaging and remote sensing is increasing rapidly. The quasi-governmental French SPOT will move to higher resolution sensors, and four U.S. companies have plans to launch earth-sensing and imaging systems in the next several years. Many foreign countries are planning significant improvement in their next-generation remote satellite system technologies.

Applications technologies closely paralleled remote-sensing satellite developments in the 1970s and 1980s. There were major advances made in such areas as the use of multispectral data to determine agricultural conditions, including soil moisture, erosion, and soil quality. Similarly, there have been major advances in the employment of both current and predictive weather data from both satellite and non-satellite systems, to assess moisture, adverse weather, and fire-warning conditions and to characterize vegetation patterns and problems.

USGS spends about $15-20 million annually to explore new applications of satellite imaging of interest to civil government activities. Since USGS acts as the lead civil agency to facilitate use of classified national security imagery, much of its research focuses on techniques to use these products. Private-sector firms such as ETAK, DeLorme, Mapinfo, and others are pursuing new commercial applications of these technologies, particularly in transportation and vehicle navigation. More advanced applications to precision farming, commercial aviation, recreational boating, and a host of other uses appear highly likely.

As to the likelihood for economic success of the commercial ventures, little is now known because most commercial satellites have yet to be launched. Existing programs, such as the U.S. LANDSAT and French SPOT, have been subsidized by government with mixed success at best. Widespread availability of high-resolution imagery also raises national security issues about its general availability and its utility to terrorists or potential adversaries.

The Internet

The industrial society has been replaced by a society in which information has increasing value, importance, and power. Constant and drastic changes in information and information technology (IT), such as use of the Internet, multimedia integration, nanotechnology, and other developments, directly impact GI. Enhanced technological capabilities are used to access, manipulate, analyze, understand, and otherwise use information. For example, the Internet has reduced the need for intermediaries or middlemen, as information can be acquired over the Internet from most states and federal agencies, some local governments, and others. The Internet allows for data transmission between what would otherwise be incompatible systems, and provides for markedly greater and easier data access than has ever before existed. Moreover, the Internet's use as a means for collaboration is just beginning to emerge, with vast potential benefits and cost savings.

The increasing availability of wide-band communications and the spread of the Internet have served to accelerate the communication and exchange of ever-larger volumes of data. USGS' EROS Data Center, for example, has rapidly expanded its telecommunications capability to 20 very large-capacity (T-1) lines and is now distributing both digital elevation models (DEMs) and digital line graphs (DLGs) on line. Some other base cartographic data, such as digital orthophoto quads (DOQs) and digital raster graphics (DRGs) are being distributed in CD-ROM form today because of bandwidth limitations.

There is a strong consensus within the communications industry that current bandwidth limitations on data transfer constraining electronic dissemination will soon be a thing of the past. Many of the data sets receiving only limited distribution in less convenient media, such as digital data tapes and CD-ROMs, are likely to transition rapidly to electronic dissemination. One of the developments facilitating this process is more sophisticated browsers that help users refine and narrow their data requests. The EROS Data Center has made major progress in developing browsing techniques to this end. This approach is increasingly likely to diminish the importance of paper map distribution, and research into cost-effective, on-demand printing would unburden further the substantial printing and warehousing costs associated with the current process of paper product distribution.

Telecommunications developments are also increasingly satisfying mobility requirements with digital wireless technologies. This is likely to both expand the volume and improve the quality of on-the-fly data collection and integration. This trend will facilitate more timely field analysis, provide feedback to field data collectors, and improve efficient and accurate collection. The benefits of mobile communications are likely to grow in importance as field data collection processes become more automated.

Proliferation of data, or "information pollution," is a growing trend and concern as governments and other organizations require and generate data to meet individual missions. Information and IT continue to be developed as "stovepipes" and used by organizations in isolation of others. As a result, these entities and users face an often confusing array of information. Government leaders and the public are more aware of redundant and incompatible information, which may conflict and cannot necessarily be integrated or analyzed effectively. They also recognize the extensive and increasing expenditure of time and resources caused by fragmented and uncoordinated efforts of multiple organizations.

Federal agency ability to communicate GI across agency lines via the Internet is still in its infancy. Firewalls erected by one agency, such as the Forest Service, to protect its data make it harder to transfer data to another agency, such as BLM. Proprietary software used to collect, store, and analyze GI creates another set of problems which are just now being addressed. Transfer of data between levels of government adds further complexity because of data incompatibility and pricing practices. Even so, problems in interoperability and transferability of data should diminish over time as agencies acquire later generation systems and further improve communications capabilities.

More information on these technological advances is provided in Chapter Seven.

Separate Paths Being Pursued in Defense and Civil Sectors

In 1995, a task force of the Defense Science Board issued a report[7] on the future operations of defense mapping which has become the foundation for actions being taken by NIMA, the successor to the Defense Mapping Agency (DMA), for building a Global Information Infrastructure (GII) to support worldwide defense operations. The task force concluded that the DoD should transition from emphasis on standard-scale map and chart production to providing a readily accessible source of digital information which will satisfy military geospatial, mapping, charting, and weapon systems requirements. This repository of digital geospatial information does not now exist, but eventually it is to be accessible electronically for a large variety of worldwide customers.

The task force report also found that DMA's reliance on a hardware structure which received imagery from only a single source was unnecessarily restrictive and should be abrogated. The agency's legacy digital production system was proprietary, closed, and expensive to maintain and needed to be replaced. The agencies recommended that DoD build on the rapidly expanding commercial capabilities to modernize the process. As a result, an Integrated Product Team composed of defense and intelligence agency officials in and outside of DoD was formed to create the new infrastructure. A joint industry-government task force is hosted by the Open GIS Consortium (OGC) a private organization, to engage relevant industry segments in the GII engineering and technology management process.*

Joint Vision 2010, the Joint Chiefs of Staff's overall information technology strategy, has as a central premise that knowledge of "mission space," which includes the geographic terrain of the battlefield, is a central premise for decisionmaking and war-fighting, and its goal is to achieve "full spectrum dominance" over any adversary, in part through information superiority. A common view of the mission space is to be keyed to a geospatial framework which includes imagery data, elevation data, and feature data. GII is to be an integral part of the overall Defense Information Infrastructure (DII).

On the civil side, the FGDC's strategy is built on a necessarily more diffuse vision of making current and accurate GI readily available to all for "economic growth, environmental quality and stability, and social progress." The four goals are:

- Increase the awareness and understanding of the vision, concepts, and benefits of the NSDI through outreach and education.
- Develop common solutions for discovery, access, and use of geospatial data in response to the needs of diverse communities.
- Use community-based approaches to develop and maintain common collections of geospatial data for sound decisionmaking.
- Build relationships among organizations to support the continuing development of the NSDI.

The means for achieving these goals include clearinghouse creation, standards development, formation of partnerships, and development of new relations that allow organizations and individuals to work together to share GI.

Thus, both the FGDC's goals and the means for achieving them necessarily are also more diffuse than those envisioned for DoD's GII. NIMA has recently forged more direct links with the private sector and has a strategy designed to make full use of private-sector capabilities while FGDC is just beginning to involve the private sector, primarily through OGC, in its activities.# At the same time, DoD and civilian efforts are both directed toward developing reasonably comprehensive GI databases, internationally and nationwide respectively. GII will rely in large part on data generated for the NSDI to meet national security needs for GI over the United States. Civil agencies will be connected to the GII and possibly the National Information Infrastructure (NII) as well. To the extent that NIMA makes its data holdings publicly available, there is risk of confusion as to which is the authoritative source to meet domestic needs.

Impacts of Societal Changes

While previously used only by professionals in related fields, GIS and automated mapping systems are increasingly used by more Americans and are available at low cost for use on personal computers. Some are even downloadable via the Internet. It is essential to recognize the complex and multi-faceted relationships between GI and society.

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* USGS and other civil agencies have worked with private contractors bilaterally on National Aerial Photography Program (NAPP) and other projects for several years.

GI was initially used in natural resources and infrastructure analysis, planning and management. However, during the last decade applications have emerged in many nontraditional areas such as health and human services, land-use planning, public safety, emergency management, economic development, public finance, education, cultural resources, and others. Moreover, applications have expanded beyond the often-routine automation of manual processes to more complex strategic applications that use sophisticated analytical capabilities to integrate and display disparate information in ways not previously understood.

Overarching Societal Changes

Several changes in society influence the development and use of GI. The rapid pace of societal change is challenging past norms, values, customs, and institutions. Society is also experiencing demographic and cultural changes, tensions between economic and environmental interests, and global interdependence among populations and natural phenomena, such as climate change, ozone depletion, and natural resource use. Governments address these increasingly complex and related problems concerning the natural, physical, and human environment. GI has been employed and increasingly is employed to understand and address these trends. However, the United States has a federal rather than unitary form of government, and federal, state, and local governments often address common problems in an independent or reactive manner, and often develop information and use information technologies in isolation of one another.

There appears to be greater recognition of the repercussions, interdependency, and time-sensitivity of decisions. There is also a greater realization of resource limitations. Public land use is evolving from primary emphasis on extraction to accommodating multiple uses. At the same time, traditional institutions and structures have struggled to develop and implement policies responsive to these changes.

Changes in Government

Society is experiencing a shift in some functions from governments to the private sector and nongovernmental organizations (NGOs). Authority, roles, and responsibilities also are devolving from the federal government to state and local governments, primarily in health and social services (see also Chapter Seven). State and local governments are seen by some as more fiscally and institutionally capable of governing than in the past, and often able to provide services at lower cost than the federal government.[9] State and local governments have their own inherent authority and roles, and they often undertake initiatives to solve problems similar to those addressed by the federal government. In particular, state and local governments develop their own GI to meet their missions and expect to continue doing so in the future, particularly with more access to better and cheaper technology.

The downsizing and decentralization of the federal government is also shifting operations from Washington-based offices to regional and field offices, as well as impacting GI. Almost nine-tenths of the total federal workforce involved with GI is located in field offices throughout the country. These offices and employees are the primary contacts for the citizenry, business community and other sectors

Other trends seem to complement government decentralization and devolution. For example, organizations are reducing and "flattening" their institutional hierarchies to reduce costs and time while increasing the use of information technology. There is more interorganizational networking and coordination, as evidenced by a proliferation of interorganizational groups and teams.

Impact of the "Information Age"

Society increasingly depends on information technology (IT) which is used for an ever-expanding array of applications which go beyond the automation of manual processes that characterized early IT uses. Organizations leverage knowledge and technology to make critical decisions, manage activities, and communicate with others. These changes are also impacting the organizations in which IT is employed, by reducing administrative structure, leveling hierarchies, and introducing greater networking, as evidenced by the proliferation of the Internet and intranets.

The "information age" provides more widely available and current information that can be disaggregated, analyzed, and integrated to solve increasingly difficult, interdependent and changing problems.

Overlap of Government Services, Operations, and Information

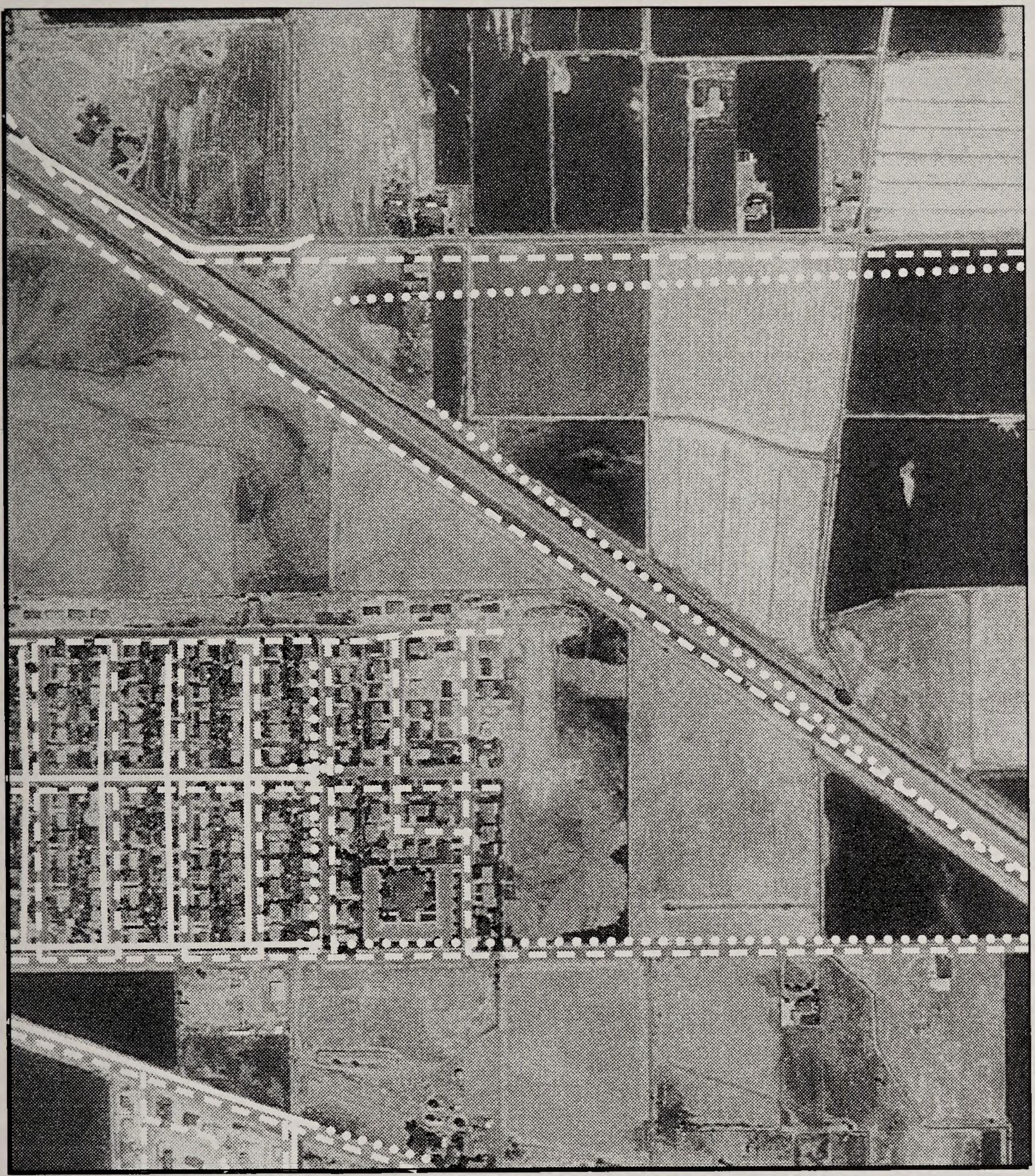
Multiple governments and agencies have jurisdiction over and provide services for the same geographic area, often with independent administrative infrastructures of offices, personnel, and systems. The cost and complexity of these government services and providers are substantial. Uncoordinated governmental activity is evident with respect to information. Differing and sometimes conflicting data often need to be reconciled to be useful "on the ground." Yet, numerous examples reveal that correct and accurate geo-referencing of data is often painstakingly developed by local governments or field offices of state and federal agencies. Moreover, these data sometimes do not translate up or down, or fit into, information systems at other levels of government.

Figure 2-3 shows how digital GI from different federal agencies do not fit and are not completely accurate when portrayed at a large scale.

A particularly obvious and costly on-the-ground example is that of uncoordinated operations of organizations servicing a specific area. For example, the number of providers is growing as the telecommunications infrastructure expands, and electric utilities with lines previously located overhead are increasingly located underground. However, such providers do not necessarily share facility maps, plans, addresses, or other information. As a result, newly repaired roads can be dug up by a utility to maintain or replace a line, although costs and public inconvenience could be minimized if work had been synchronized. Unavailable or incorrect information about utility line locations has meant that such lines have been broken, property damaged, and even lives lost.

Utility notification centers began to be formed during the 1960s to provide locational information and suggest that contractors and others "call before you dig." However, the information at these centers is quite general and may not be accurately geo-referenced using modern technologies, and efforts are usually not taken to reconcile data differences. In many cases, no entity is officially responsible and/or no actions are being taken to manage information within rights-of-way, causing this problem to perpetuate.

FIGURE 2-3: FEDERAL DATA DISCREPANCIES: DIFFERING AGENCY DATA ENCOURAGES INTEGRATION, RECONCILIATION, AND COLLABORATIVE DATA REVISIONS



New large scale Digital Orthophotograph Quadrangles (DOQs) are being developed throughout the U.S. with USDA and Interior funding. DOQs reveal discrepancies of older, smaller scale digital data produced by individual federal agencies, such as the U.S. Geological Survey (Digital Line Graphs), the Forest Service (Cartographic Feature File), and the Census Bureau (Topologically Integrated Geographic Encoding and Referencing [TIGER] system). Policy-level decisionmaking and every day management and operational needs encourage local, state, and federal agencies to work together to reconcile differences, and integrate and maintain data to more accurately reflect reality.

Fiscal limitations, downsizing, privatization, devolution, and decentralization are a few of the societal and governance trends which drive new governmental approaches and coordination. Governments are simplifying and streamlining processes to improve effectiveness, better serve the public, provide data access, and enable the public to have more input in decisionmaking. Government "reinvention" advocates support greater government entrepreneurship, flexibility, and adaptability to respond to these trends, along with the formation of new government models, structures, and interorganizational relationships.[10]

Emerging Geographic Perspective

As the volume, use and growing demand for GI and information technologies proliferates, society requires commonly understood reference bases or foundations with which to link and combine information. Several "information foundations" or "touchstones" have evolved through time. For example, much information is referenced and can be accessed by individuals through a unique identifier, the social security number.

There is now an acknowledged need for a similar information referencing scheme for "space" or geographic location. This sense of "place" is becoming more important to society and citizens. The ability is now at hand to connect people, place, and collective decisions in a more democratic way.

Opportunities to Maximize Geographic Perspective

When complemented with increasing proliferation and use of GI and related technologies such as GIS, geography is becoming a useful perspective to enhance the processes and outcomes of government, business, and society. Public and private organizations alike use geography and location as a linking reference to disaggregate, integrate, and portray data in ways not possible before GIS. For example, private companies use GIS to maximize service routing and target marketing efforts. Representatives of companies such as Federal Express and Pizza Hut attest to the criticality of this approach to their strategy and success.

GIS and the geographic perspectives they generate provide a means for governments to facilitate interorganizational understanding, cooperation, collaborative analysis and decisionmaking, while identifying overlapping or conflicting activities on the ground. GIS can improve the effectiveness management and operations of services and programs while helping resolve conflict and controversy between organizations and the public. Moreover, it can help in understanding and reconciling data generated by multiple organizations and in reducing data redundancy, fragmentation, and costs.

Socialization of Geographic Perspective

While GIS was previously only used by certain disciplines, such as natural scientists, geographers, engineers and surveyors, information referenced by location and related technologies are increasingly used by people in other professions, as well as the general public. Geographic approaches and "data democratization" mean that the public is better able to understand conditions and options that affect them, and participate in decisionmaking more than ever before.

Many hurdles must be overcome to realize the benefits of GIS. Agreement on and clarity of definitions of terms in research and practice is important. Numerous disagreements and confusion exist in the use and definitions of terms related to GI and GIS.

Moreover, each discipline involved with GIS develops its boundaries and its way of viewing the world. Many guilds and disciplines (including surveyors, highway engineers, soils scientists, foresters, property appraisers, planners, petroleum geologists, ecologists, and more), though they all use GI and GIS, are trained in very different ways and use very different terminology.

Societal Concerns Regarding Geographic Perspective and GI Use

One of the downsides of GI, like many other kinds of automated information, is that "reality" essentially can be misinterpreted.[11] Criminal and terrorist access and use of GI is also a threat, because better access to information such as the location of facilities or resources heightens risk of theft or destruction, as has been experienced with numerous archeological resources.

The widespread access to GI and GIS for stakeholders involved in public policy processes has elevated attention to ethical and equity concerns regarding GI availability and use. For example, GI has been used by citizens to ensure "environmental justice" and that less-desirable facilities are not located near their homes and businesses.

Influences on Governmental Mission Performance

There are several governmental actions and trends being taken in response to the societal and governance changes described above. Governments are employing geographic perspectives to improve the effectiveness of decisionmaking, management, coordination, and other processes, such as:

- "one-stop shopping" or permitting initiatives
- modernization of land information systems
- integrated approaches to ecosystem management
- place-based decisionmaking.

These trends are discussed in more detail in Chapter Three.

THE PANEL'S VISION — WHERE GEOGRAPHIC INFORMATION IS HEADED

The research performed for this study was most helpful to the panel in arriving at its conclusions and recommendations, but neither the research nor the recommendations could be formulated in a vacuum. For a topic as encompassing as this one, some limits had to be set on the areas of exploration. In addition, the panel needed as good a fix as it could get on the future and a vision of where GI is headed.

Underlying Assumptions

The economic impacts, societal changes, and governance trends mentioned above, provide the context for addressing the four sets of questions posed by the study sponsors. To help guide the study research, the project staff developed a list of underlying assumptions about GI. The list, categorized by subject area, was extensively revised and refined based on staff research and analysis and panel deliberations. Selected policy assumptions are listed in italics and discussed below. (A complete list is included as Appendix C.)

Assumption No. 1: **Establishing the policies, procedures, and standards that are to compose the NSDI is a worthwhile national goal; appropriate steps should be taken by all sectors, working together with federal leadership, to help establish and implement them.**

Many organizations are now involved in collecting, maintaining, and/or disseminating geographic information. There are over 40 such organizations in the federal government, and the number will undoubtedly grow with the proliferation of GIS capability across government. Staff visits to several states confirmed that the number of state organizations involved is almost as large. Many state collectors and processors of geospatial data have their own mechanisms similar to the FGDC for coordinating their efforts, such as a state geographic information council or central administrative organization. At the city and county levels, some governments have consolidated their GIS activities while others still maintain separate operations to meet unique mission needs.

The Panel is convinced that policies and standards supporting an NSDI could be improved and costs could be lowered if governments would (1) work more closely with each other and with the private sector to pool resources and (2) build upon common standards wherever possible that would allow data to serve multiple interests. (FGDC staff said this is the underlying principle of the current FGDC approach.)

Assumption No. 2: **Governments, independently and collectively, have essential roles in the information age in data acquisition, coordination, clearinghouse management, standardization, quality assurance, and development and maintenance of geospatial databases for the public good that cannot be achieved without an agreed-upon foundation; a diversity of additional data layers, so-called framework data, need to be maintained.**

In its 1995 report, the MSC defined the foundation for the NSDI as geodetic control, digital terrain elevation, and orthoimagery. The FGDC report on framework also helped set goals for a GI foundation (see also Chapter Five). The MSC also recognized that so-called framework data — data beyond the base foundation — form the basis for spatial information and analyses and that different data sets could form distinct frameworks. It emphasized that "*multiple frameworks could be established . . . just as there might be frameworks that differ by type of analysis, the framework data also could differ by geographic region.*" The MSC did not expect that "the same level of accuracy or even the same framework layers will be compiled (or needed) in the near future over the entire United States. Instead, the MSC suggested criteria —broadest constituency, return on investment, management of critical resources, and fundamental to other spatial data.

Assumption No. 3: **Society benefits and decisionmaking improves if geospatial data produced by governments at all levels, either directly or through its contractors, to meet mission needs are available to the public free or at reasonable cost. Widely available data enhances citizens' capacities to participate in the democratic process.**

The U.S. government has a long tradition of making information produced with federal funds for program purposes available to the public for free or at the cost of reproduction. OMB Circular A-130 provides that agencies shall, in part, (1) avoid establishing or permitting others to establish on their behalf exclusive, restricted, or other distribution arrangements that interfere with the availability of information dissemination products on a timely and equitable basis; and (2) set user charges for information dissemination products at a level sufficient to recover the cost of dissemination but no higher. They shall exclude from calculation of the charges costs associated with original collection and processing of the information. (BLM noted, for example, that its Geographic Coordinate Database is available on the Internet for customer access. Because the actual time spent on BLM's server is negligable, there is no charge. On the other hand, value-added data from the private sector is costly.)

At the state and local levels, many governments have requirements that information available to decisionmakers must also be available to citizens affected by those decisions. Such data therefore cannot be restricted by copyright or other protections normally afforded to proprietary data. However, others increasingly want to charge users to offset the full cost of the product or, sometimes, to stimulate revenues from public sales. In addition, certain spatial data can be restricted by copyright or other protections normally afforded to proprietary data.

Assumption No. 4: **The federal government uses the private sector, as well as state and local governments, to meet its geospatial data needs where there is capacity to do so at competitive costs. As additional private sector capabilities become available at reasonable cost and timeliness, federal agencies seek to take advantage of them, even if one result is curtailing or dismantling existing governmental facilities over time. The extent of governments' reliance on the private sector depends in part on the need to retain in-house capacity for contracting and program management and the inherent or underlying public purposes being served.**

OMB Circular A-76 states that, "In the process of governing, the Government should not compete with its citizens. The competitive enterprise system, characterized by individual freedom and initiative, is the primary source of national economic strength. In recognition of this principle, it has been and continues to be the general policy of the Government to rely on commercial sources to supply the products and services the Government needs." The circular also says "the Government shall not start or carry on any activity to provide a commercial product or service if the product or service can be procured more economically from a commercial source."

Likely Future Trends

The MSC, in cooperation with the FGDC, convened a workshop in April 1996 to examine societal and technological changes that might occur within the next 15 years.[12] The purpose was to consider within the context of spatial data activities a series of long-term visions and to identify societal forces and changes that would make those visions more or less likely. The workshop provided an opportunity for thinking about the future of U.S. spatial data activities. Among the anticipated changes identified by the participants were the following:

- Improvement in basic computing and telecommunications technology will continue, as will improved access to data and the technology. Spatial data also will become transparent to users.

- Needs for currentness will change data management, and there will be more local collection of spatial data. Transactional updates will become a major data source.
- Data utilities may emerge and consumers will drive data markets. Restrictions on public access may grow as well.
- Spatial analysis will continue to grow in importance, and spatial capabilities will expand public involvement.
- Conflicting public policies will continue as will the trend of increasing privatization.

Not surprisingly, the workshop participants reached no conclusive consensus on the future of spatial data and society. However, the participants saw value in considering the range of forces at work and the possible changes those forces may produce. The report said: "An organization that has a stake in the future of spatial data will find that its strategic planning must be guided by changes that most certainly will occur and also by changes that may occur only if specific pathways are chosen or influenced."

The Panel agrees with this statement and its application to federal geographic information.

TOWARD A NATIONAL SPATIAL DATA INFRASTRUCTURE

Compared to the nation's interconnected system of highways, roads, and streets, spatial data is still poorly connected and coordinated. Through the Internet, spatial data are becoming much more widely available, but locating and making use of it, either on one's own or in connection with similar data, even relative to the same geographic area, usually poses formidable challenges. Government agencies and levels of government are cooperating and forming partnerships on spatial data more than ever, but much more progress can be made in reducing overlap and duplication, particularly between governmental levels.

In 1993, the MSC found two major obstacles to improving efficiency. First, there were serious impediments to coordination and efficiency, including the traditional arrangements for creating, disseminating, using, and paying for maps that do not necessarily work well in the digital spatial data era. Second, there was no system of incentives to direct public and private funding toward more coordination and efficiency.[13] Agencies are naturally driven by the imperatives of their own missions, program priorities, and laws which guide their activities, although bipartisan drives to reduce government budgets and rely more on the private sector have caused some serious rethinking of the scope and reach of spatial data functions.

NSDI Concepts

The scope and dimensions of an NSDI are becoming clearer. In a recent strategy document, the FGDC presented the following vision:

> *Current and accurate data will be readily available to contribute locally, nationally, and globally to economic growth, environmental quality and stability, and social progress.*

The administration sees the NSDI as part of the evolving National Information Infrastructure providing citizen access to information and thus strengthening the democratic process. Greater sharing and better access to high-quality data is also seen as improving the well-being of communities and helping to provide for responsible stewardship of natural resources for sustainable development.[14]

Currently, some geospatial data are available through the FGDC clearinghouse in both analog and digital form in databases scattered through all levels of government and in the private sector. Hard-copy maps and charts still make up a substantial component of the clearinghouse; they are updated periodically and reprinted or converted to digital formats as needed and when funding permits. In terms of coverage, geospatial digital data on many basic geographic features exist in current and usable form nationwide, but for secondary themes they exist for only a fraction of the total land mass. For coastal waters, nautical charts are fully current and accurate only for the highest-traffic ports, harbors, and waterways.

The NSDI policies, standards, and activities emerging under FGDC guidance offer the prospect of providing for far more comprehensive, integrated, and available data than what exists today. The listing below synthesizes the characteristics of an NSDI "ideal."

Toward an NSDI Ideal

- There is a common spatial data foundation organized according to widely accepted layers and scales (or resolution) that is available for the entire area of geographic coverage (parcel, neighborhood, city, county, state, nation, etc.) to which other geospatial data can be easily referenced.
- The foundation data is readily accessible and available at no or little cost from user-friendly and seamless sources to meet public needs and encourage conformance with it by producers of other geospatial data.
- Both foundation and other geospatial data, as required and specified cooperatively by data producers and users, is updated according to commonly accepted standards and measures of quality.
- Thematic and tabular data are also available on terms not incompatible with the foundation data.
- When cost-effective, geospatial data produced by one organization, political jurisdiction, or nation is compatible with similar data produced by other organizations, political jurisdictions or nations.
- Geospatial data can be integrated with many other kinds or sets of data to produce information useful for decisionmakers and the public, when appropriate.
- Responsibility for generating, maintaining, and distributing the data is widely shared by different levels of government and the private sector. Governments take advantage of private-sector capabilities available at reasonable prices rather than maintaining dedicated capabilities.
- The costs of generating, maintaining, and distributing such data are justified in terms of public benefits and/or private gains; overlap and duplication among participating organizations is avoided wherever possible.

In this ideal NSDI world, foundation data would be up and running according to agreed-upon standards in a variety of scales usable to the widest number of users.

Additional geographic layers or thematic and tabular data could be added to this foundation from other sources, if required, for understanding and analysis. There would be suitable horizontal geodetic control and base orthophotography so that the data layers would easily overlay, one on top of the other, and they could be combined with a wide variety of other spatial data prepared according to compatible standards and specifications. Foundation data would be kept current; and other data would be updated as required and be available in user-friendly formats. Tabular data would be commonly geo-referenced so that it could be utilized accurately with geographic data in a GIS. The panel believes this NSDI ideal is a useful goal toward which all parties involved in GI can be working.

However, there are problems with this approach, including:

- **No one has attempted to estimate comprehensively the benefits and costs of creating such an NSDI ideal.** In the 1993 NPR report recommending an NSDI, it was estimated that acquisition of a "basic national data set for identified high-priority areas," with significant nonfederal cost-sharing, would cost about $20-30 million annually.[15] A more ambitious approach which included accelerated collection of thematic data and base data for "moderate priority areas" would require $50-75 million annually in new federal investment. NPR asserted that these amounts were small compared to what would be spent if the federal government proceeded with an uncoordinated effort. No estimate was given for state and local government or private-sector expenditures.
- **Each federal agency has its own set of goals and strategies, only some of which are explicitly tied to the NSDI policies and programs.** The FGDC strategy document spells out several goals and objectives, but there are no dollars or time lines associated with them, nor is there linkage to the agency strategies. Nonetheless, federal agencies and many states are rapidly proliferating databases and Web sites which help users locate existing data, but more effort is needed on common standards to ensure minimum quality and on assigning and coordinating responsibilities among units and levels of government and with the private sector.
- **There has been no national debate on the merits and challenges of furthering an NSDI, and knowledge of and support for the effort among the general public are not widespread.** Interviews conducted by the project staff with officials in the Executive Office of the President and Congress have confirmed that a coordinated spatial data infrastructure is not a high priority on the nation's political radar screen. However, there is enthusiasm among most elements of the geospatial data community for an NSDI and growing awareness among policy and political elements.
- **Some important scientific and technological challenges have not been surmounted.** Chief among these is the complexity of merging spatial data generated by different sources. For example, NRCS collects data at one resolution and USGS at another. GIS provides only overlays; the data cannot be fully integrated. Attention needs to be given to integrated mapping approaches. The recently formed OGC is attempting to address this issue but only at the technical data structure level.

- **There are still significant impediments to, and few workable incentives for, the generating of compatible spatial data among federal, state, and local organizations.** There are few disincentives to the sharing of data, but, as the MSC noted in 1993, agencies would have to agree in advance on the uses, types, and formats of data to achieve compatibility. This could require one agency to collect, at its expense, more data than it requires in order to satisfy another agency's needs – an unlikely outcome in today's world of fiscal constraints at federal, state, and local levels – or necessitate agreement on a cost-sharing formula. Even if this should happen, the gaining agency would become dependent on the collecting agency to acquire the data with the needed rigor, accuracy, and timeliness. These problems are compounded when different levels of government are the data producers and users.
- **No entity is responsible or accountable for defining roles for the NSDI while new roles are emerging for governments, such as data stewards, data integrators, and data providers.** Moreover, existing financing mechanisms are not well suited to providing the needed support. (FGDC staff advised that one of the fundamental characteristics of the NSDI is that no one is (or can be) "in charge." They believe that the assumption that some "entity" can be "responsible and accountable" leads to concepts that may be less successful than an informal, "web-like" interaction of interested participants.)

Remarkable progress has been made on the NSDI within the past few years, notwithstanding the challenges and uncertainties outlined above. Furthering a spatial infrastructure even remotely resembling the NSDI ideal outlined above is an enormous undertaking, however. It will require years just to reach the point of establishing when shared ownership and responsibility among disparate agencies and levels of government are possible and sustainable. In many cases, differing demands or alternative political perspectives will make this impossible. Realistically, the NSDI will never reflect all the elements envisioned, if for no other reason than the passage of time and the advance of technology will necessitate further changes. However, a sense of direction and accountability are essential to any complex undertaking, especially when so many different actors and funding sources are involved.

The Next Steps in Realizing an NSDI

To move more rapidly beyond the first promising steps in furthering an NSDI, the panel believes improvements in the policy base, governance structure, coordination mechanisms, and a re-balancing of responsibilities among governmental layers and with the private sector would be highly beneficial.

Other Academy studies have established that the length of time needed for substantive organizational change demands sustained leadership, a comprehensive strategy, and the incentives to support it.[16] Such change usually takes longer to complete than a single presidential term or the typical tenure of departmental leadership in the federal government. The task of furthering an NSDI is complex and far-reaching and can only be accomplished by evolutionary change. No revolutionary changes in policies, organizational structure, or programs are required, but sustained effort by a wide array of governmental and private actors will be required over a lengthy period.

TABLE 2-2: ELEMENTS OF THE POLICY BASE AND GOVERNANCE STRUCTURE

Policy Base	▪ Identifies major purposes relevant to today's and tomorrow's GI needs ▪ Defines and describes an NSDI. ▪ Creates coordinating and operational mechanisms with appropriate representation from federal, state, local and tribal governments, academia, and the private sector. ▪ Sets national goals and timelines for furthering an NSDI. ▪ Provides appropriate charters for the governmental organizations responsible for base geographic data.
Coordination	▪ Provides federal coordinating committee with cabinet-level chair. ▪ Has subcommittees and work groups appropriate for achieving NSDI goals. ▪ Provides demonstration grants to promote data sharing with both public and private entities and build capacities at all levels of government. ▪ Has a national organization with all sectors represented to establish a strategy to accomplish the national goals and monitor implementation. ▪ Coordinates development of widely-accepted national standards as needed for the NSDI and operates a user-responsive clearinghouse which permits easy access to a wide range of spatial data.
Structure and Organization	▪ Assigns responsibility to a flexible, geographically-oriented organization for assuring creation and maintenance of the foundation layers – geodetic control, digital elevation, and orthoimagery – that allows expansion and contraction of resources responsive to customer needs. ▪ Assigns lead governmental level and agency responsibilities for other framework layers. ▪ Defines and distributes roles and responsibilities appropriately across levels of government. ▪ Arranges for other levels and units of government and private sector participation to further an NSDI.
Coordinating Mechanisms and Rebalancing Responsibilities	▪ Coordinates work among federal, state, local, and private organizations on their contributions to data layers. ▪ Provides federal field officials with sufficient authority to work with each other and with state and local governments. ▪ Establishes cross-servicing arrangements to eliminate overlap and duplication in GI data collection, maintenance, and distribution. ▪ Promotes consortium arrangements to facilitate cooperative data collection and processing efforts.. ▪ Provides communications capacity to conveniently and readily exchange data among federal agencies and between levels of government. ▪ Private-sector capabilities fully developed, used, and integrated with governmental efforts in developing and maintaining the NSDI.

The potential elements and attributes of the laws and executive orders, organization structures, coordinating mechanisms, and the re-balancing of responsibilities necessary to further an NSDI more rapidly are listed in the Table 2-2.

The above table outlines the major elements the panel believes are necessary to further an NSDI that fulfills the aspirations of Executive Order 12906 and its proponents. Many actions have already been taken and others are underway to put some of these elements in place; others, such as creating a formal national coordinating body with appropriate federal, state, and local government representation, would necessitate legislation.

The panel believes that legislation is needed, but the case for anything beyond the current executive order still needs to be made. Neither the administration, major federal GI agencies, nor their congressional mentors seem inclined to propose and pass a new law even if they were well-positioned to do so. At the same time, although the FGDC has promulgated a vision, goals, and objectives for achieving an NSDI, no one has thought through all of the elements needed to convert the aspirations into reality within a reasonable time. In addition, the current steps that are being taken by the federal government are necessary whether or not a new statutory charter is enacted. This report can serve as a starting point, but much additional work will be needed to get a bill introduced and enacted into law.

Before a legislative initiative can succeed, governments need to establish whether and when transactionally updated, multiple-layer, and multi-scale sets of electronic GI generated by coordinated contributions of all levels of government and the private sector can work and are cost-effective. Good progress has been made to make better use of state/local and private-sector capabilities, but agencies involved in GI need to gain greater confidence in their ability to rely on others to help carry out their missions.

Drafting a statutory charter based on the current FGDC and NSDI charters may be beneficial in helping to promote a political consensus supportive of NSDI efforts. Meanwhile, actions now underway or planned should move forward and the panel's recommendations in succeeding chapters for building on the progress already being made in standards, coordination, cooperation, and re-balancing should be implemented by the FGDC, federal agencies, other levels of government, and the private sector.

ENDNOTES

[1] National Research Council, Mapping Science Committee, *Toward a Coordinated Spatial Data Infrastructure for the Nation* (Washington, DC: National Academy Press, 1993), p. 2.

[2] Vice President Al Gore, *Creating a Government the Works Better and Costs Less: Department of the Interior* (Washington, DC: GPO, 1993).

[3] Carl Calvert, Keith Murray, and Neil Smith, "New Technology and Its Impact on the Framework of the World," in *Framework for the World,* David Rhind, ed. (New York, NY: John Wiley & Sons, 1997), p. 133.

[4] *Ibid.*, p. 134.

[5] National Academy of Public Administration/National Research Council, *The Global Positioning System: Charting the Future* (Washington, DC: National Academy of Public Administration, 1995), pp. 14-40.

[6] Http://www.esri.com/base/gis/abtgis/what_gis/html (August 1997).

[7] Defense Science Board, *Task Force Report on the Future Operations for Defense Mapping* (Washington, DC: Department of Defense, 1995).

[8] Http://www.opengis.org/info/brochure/brochure_1.hm (August 1997).

[9] Evan J. Ringquist, *Environmental Protection at the State Level: Politics and Progress in Controlling Pollution* (New York: M.D. Sharpe, Inc., 1993), p. 63.

[10] David Osborne and Ted Gaebler, *Reinventing Government: How the Entrepreneurial Spirit Is Transforming the Public Sector* (Reading, MA: Addison-Wesley Publishing, Inc., 1992).

[11] Mark Mononier, *How to Live with Maps* (Chicago: The University of Chicago Press, 1995), pp. 59-60.

[12] National Research Council, *The Future of Data and Society: Summary of a Workshop* (Washington, DC: National Academy Press, 1997).

[13] National Research Council, 1993, p. 20.

[14] Federal Geographic Data Committee, *A Strategy for the National Spatial Data Infrastructure* (Washington, DC: FGDC, 1997), p. 7.

[15] Gore, 1993.

[16] See, for example, National Academy of Public Administration, *Renewing HUD: A Long-term Agenda for Effective Performance* (Washington, DC: National Academy of Public Administration, 1994), p. 177.

CHAPTER 3

Geography-based Public Purposes and Geographic Information Roles

This chapter addresses the following questions:

- *Which surveying, mapping, and GI activities serve fundamental public purposes?*
- *Which are most appropriate to be performed by the federal government and which by the state or local governments, or by the private sector?*

THE NATURE OF GEOGRAPHY-BASED PUBLIC PURPOSES

Public purposes are what the public – acting through governments – has articulated as the desired goals, outcomes, or results of public action in institutions, or in legislation and ordinances. Essentially, they are those actions that are to be undertaken collectively. They generally are taken on by government because a large number of people benefit, and it is difficult or deemed unwise to exclude anyone from benefiting. In some cases, it is important for governments to provide uniformity to help ensure public safety.

Governments inherently have the responsibility to represent the public's interests, not just the interests of particular segments of society, to ensure the general welfare and guard against predatory practices, and to provide economic and societal stability. Governments represent the public's common interests. These characteristics of governments position them best to:

- ensure sound stewardship of the government's natural and economic resources
- take responsibility for archiving the government's information resources
- arbitrate legal disputes, including those involving land boundaries
- absorb broad liability for public safety
- respond to emergencies arising from natural hazards, civil disorder, and military action

The public purposes that emerge from the constitution and laws of the nation focus on key public goals or needs or on problem areas require a threshold level of substantive expertise and performance capacity. They are assigned to organizations within the federal government and state or local governments, and are integrated into the larger issues of governing, including reinvention and reform initiatives.

Geography-based Public Purposes and GI Roles

Governments are inherently geographic – being territorial jurisdictions with responsibilities for programs that benefit the peoples, lands, economies, and other enterprises within their borders –and they are highly dependent on GI and major sources of it.

Through the years, the federal government has established several civilian mapping, charting, and surveying activities to serve its public purposes.[1] As stated by current laws and policies,[2] these GI activities include:

- providing nationwide systems of horizontal geodetic control, elevations, and bathymetry to help support navigation, trade, exploration, and land policies
- surveying the boundaries of public lands to (1) establish an orderly land record system, and (2) support ongoing management of the federal public lands, including administration of land-use authorizations which transfer certain parts of the "bundle of rights" associated with land ownership and transferring land to states and private parties, sometimes to raise revenue.
- providing air and water navigation charts to help improve the nation's transportation systems
- providing maps for use by census-takers, land managers, planners, developers, recreationalists, commercial and nonprofit mapmakers, transportation industries, commercial and sports fishermen, and many other groups and members of the public
- establishing satellite-based earth imaging and geo-positioning systems, initially for military and intelligence purposes, but now also serving many diverse civilian applications
- integrating GI derived from many different sources to help improve the effectiveness, efficiency, and quality of government services, and to help spur the nation's economy

The broader public purposes behind these activities include responsible stewardship of the public lands, promotion of interstate and foreign commerce, promotion of economic development, protection of the environment, and transfer of public research findings into practical civilian and commercial mapping, surveying, and GI applications. The historical evolution and current status of the federal government's primary GI programs are summarized elsewhere in this report (see Appendix E).

Almost all of the nation's governments acquire GI, and so does the private sector. Frequently, public and private sources of GI are closely interrelated.

INFLUENCES ON GOVERNMENTAL MISSION PERFORMANCE

There are several governmental actions and trends being taken in response to the societal and governing changes described in Chapter Two. Governments are employing a geographic perspective to improve the effectiveness of decisionmaking, management, coordination, and other processes. Some examples are provided below.

"One-Stop Shopping and Permitting" Initiatives

Thousands of federal, state, and local government agencies operate facilities throughout the country to fulfill individual missions. Most government offices have been located with little regard to the location of other public agencies and services. As a result, citizens and businesses must go to multiple offices to conduct related business such as obtaining licenses and permits, accessing land records, and paying taxes. Companies and the public increasingly complain about the inefficiencies of lengthy and costly interactions with several, and often incompatible and archaic, government offices. In a modern permit office, an applicant should have to fill out only one form for the whole set of related transactions. This would save government, as well as the applicant, time and money. And, the added efficiency would help to spur economic development.

Efforts are underway in government to work more efficiently with others and provide better public and governmental access to GI by creating "seamless government" among multiple federal, state, and local agencies. There are numerous initiatives to establish "common points of presence" or "one-stop shopping" in terms of physically collocating offices. This approach also extends to providing automated access to information holdings of different agencies in different locations. For example, the General Services Administration (GSA) has initiated efforts to coordinate various federal information systems with state and local governments. It has one project with Iowa that specifically addresses GI because that state identified GI as one of its strategic priorities for improved intergovernmental information sharing.

Several efforts are now under way to collocate federal employees and offices with those of other agencies to minimize federal expenses and improve services. For example, with support from the Secretary of Interior and others, the BLM and Forest Service are combining forces on some adjacent lands in Colorado and Oregon to serve common customers with one-stop shopping "Trading Posts." Moreover, $5 million is being spent to integrate the Forest Service's regional office with the BLM's state office in Portland OR. Rather than just being collocated in the same building, similar staffs from the two agencies will be located in close proximity to each other to facilitate the many fluid interactions needed to help the agencies accomplish similar work on adjacent lands.

"One-stop permitting" is also a new initiative of the Environmental Protection Agency (EPA). This approach will enable regulated facilities to obtain permits more quickly and efficiently, particularly those that require multiple permits necessitating interaction with several offices. Instead of the previous "stovepipe" approach for various environmental media, with associated difficulty in evaluating the interrelationship and combined impacts of permits, this initiative promises to reduce the work required of permittees and regulators.

Modernization of Land Information Systems

Land is becoming increasingly developed and valuable as the country becomes more urbanized and more densely populated. These conditions increase the costs, liability, and complexity of land transfer, use, management, and development for the private and public sectors alike. This trend creates important policy issues that should be addressed by contending parties, using the highest quality and most current GI possible. The antiquated, redundant, and often incompatible land information systems which exist in many parts of the country exacerbate policy conflicts.

Traditionally, local government clerks, recorders, assessors, planners, and building inspectors all have some responsibility regarding land parcel information. Citizens also must interact with private surveyors, title insurers, real estate attorneys, engineers, and others regarding development, financing, and title exchange of property.

Land information modernization has been repeatedly recommended over the years, and it has occurred in some places. Improvements need to occur in more places to help reduce costs and delays in both the public and private sectors. Moreover, effective use of modern GI technologies can help to overcome these circumstances. If all local land record offices required surveyors to present their surveys with a link to real-world coordinates and a digital file, land information systems and cadastral records would be greatly enhanced.

Some localities are developing integrated land information systems, with focal points or one-stop shopping for GI, as well as using GI-referencing schemes. Wisconsin has a unique program funded by land transaction fees to stimulate modernization of land information in each of the state's counties. Additional localities in other states are also modernizing their systems, particularly in response to increasing urbanization, land development, and associated costs. In Puerto Rico, the whole land information modernization effort is being funded by private investment, based on a pledge of fees from each property tax transaction.

Ecosystems Management Approaches

Environmental awareness has been increasing since the 1960s. Natural resources now are recognized to be scarce and fragile, and environmental protection remains an important societal concern. The significance of biodiversity and ecosystems information for helping to understand, manage, and protect natural resources and the environment is experiencing growing acceptance. At the same time, traditional jurisdictional boundaries are not as relevant to environmental conditions and concerns because the actions of individual land owners increasingly impact lands in other political jurisdictions. Accordingly, there is a growing desire to understand and manage ecosystems regardless of administrative and ownership boundaries.

While individual agencies are adopting their own ecosystems approaches to planning and land management activities, there is increasing governmental emphasis on regional approaches in many parts of the country. Interagency ecosystems approaches have been initiated since the 1980s in areas including the Great Lakes, Chesapeake Bay, Pacific Northwest, San Francisco Bay, Colorado Plateau, Gulf of Mexico, and the Columbia Basin. These efforts are usually led by one or two federal agencies. Typically they include federal agencies, and sometimes involve state and local governments as equal participants. Each of these examples uses geography as a common reference to understand and address local conditions.

Place-based Decisionmaking

The ecosystems initiatives for large geographic areas that cross state boundaries, identified above, are primarily led by federal agencies. Both, nationwide and regional environmental assessments have been attempted. Examples include EPA's Environmental Monitoring and Assessment Project (EMAP), which is nationwide, and the Northwest Forest Plan, which is regional. A number of regional estuary planning processes also have been established by EPA.

Societal and governance changes have led the federal government to encourage decisionmaking for smaller areas in a new "place-based" approach that depends on collaboration with localities. Various trends drive attention to conditions as they exist in a place, local community, or from an on-the-ground perspective. Government leaders at all levels have experienced resistance when decisions were made without involving the public, such as a land-use decision to locate an industry or waste facility near residential areas. The terms "environmental justice" and "not in my backyard" (NIMBY) are now well-known characterizations of public reactions that have forced governments to consider fairness and equity more thoroughly as they make decisions.

This place-based perspective means that multiple factors are considered in decisionmaking. The concept of "sustainable development" is endorsed by several recent federal initiatives, including the President's Council on Sustainable Development. The Council concluded that reforms are needed to help shift focus from the narrow goal of environmental protection to the broader goal of sustainable development. Because most states have increasing capacities to operate modern performance-based environmental regulatory programs, reforms are under way to move from a federally focused governmental decisionmaking structure to a collaborative design that shares responsibility among levels of government.

The second reform endorsed by the council was to shift from centralized environmental regulation that is organized around separate programs to protect air, water, and land to a comprehensive place-based approach. The council concluded that a new system to accomplish these reforms needs to "rely heavily on partnerships among federal, regional, state, local, and tribal levels of government." It specifically recommended action to "create intergovernmental partnerships to pursue economic prosperity, environmental protection, and social equity in an integrated way." The council also called for expanded collaboration between governments and the private sector to develop "compatible information databases" and to set priorities for data collection and analysis, including identification of the most useful formats for dissemination and additional mechanisms to help ensure that communities can obtain the information needed to guide sustainable development at the local level.[3]

In addition, Interior Secretary Bruce Babbitt has indicated that watershed and other ecosystems are appropriate geographic areas for understanding conditions and resolving differences. Watersheds already serve as rallying points for multiple jurisdictions and stakeholders. Over 800 watershed councils and groups have been initiated at regional and local levels in both rural and urban areas.

Several federal agencies have adopted a watershed approach. Within EPA, the water, superfund, and brownfields programs are all shifting to community-based management, including some locally negotiated agreements for protecting watersheds. EPA and some states have devolved significant decisionmaking authority to some communities for watershed management, as well as for brownfields.

A key component of this EPA effort is to make data at various scales available to the public for decisionmaking. For example, EPA's goal to make watershed planning a nationwide effort is supported with government-provided GI and GIS tools. EPA's National Watershed Assessment Project (NWAP) is providing GIS for 2,150 watersheds to use for water-quality assessment, but the agency is participating actively in only a small number of locations. The thrust is to make this data available to help encourage and facilitate collaborative watershed protection efforts.

Some states are already funding related efforts through watershed councils, while many watershed initiatives are emerging independently at local levels. The watershed perspective is also increasing with EPA's growing attention to geo-referenced environmental indicators to measure its performance and that of state agencies receiving federal funds.

In addition, the National Oceanic and Atmospheric Administration (NOAA) is developing a place-based strategy with its San Francisco Bay Demonstration Project, which is expanding to become a Pacific Coast Program. In addition, the agency's nautical charting and geodesy activities, which are highly centralized, are evolving into a new presence in local areas where there is a strong interest in meeting federal missions while producing more locally tailored products. Another example is the nationwide program of NOAA's Coastal Services Center which primarily aids state governments in meeting their missions. The Tennessee Valley Authority (TVA) also has a clean water initiative to break down barriers in its region in order to forge new alliances for meeting the goals of the Clean Water Act.

RELATIONSHIPS BETWEEN PUBLIC PURPOSES AND GEOGRAPHIC INFORMATION (GI)

In reevaluating current federal GI roles, the first issue is whether these roles remain essential to the nation's well-being and continued competitiveness in today's rapidly globalizing economy. This question is coupled with a second question: "What are the most important uses of this information on a national scale?"

The broad constitutional and legislated purposes of the federal government have changed dramatically over the years, and their reliance on GI has increased and become more complex in recent years. No longer will a few basic maps suffice; instead, a wide-ranging set of "data layers" is now required to meet federal purposes.

Table 3-1 lists 12 major public purposes of the federal government that now rely on GI, and shows how they relate to 14 common types of GI that the federal government collects. The striking point illustrated by this table is that all of these federal government purposes rely on multiple types of GI – some more so than on others. The program areas using the largest number of geodata types are public land management, environmental and ecosystem management, community and economic development, emergency management, and public information.

The federal government's involvement in these 12 geography-based public purposes, along with the involvement of the federal agencies' many relationships with state and local governments in pursuing these purposes, is detailed elsewhere (see Appendix I). Some of these purposes are pursued directly by the federal government (management of public lands and nautical charting, for example), while others are pursued in partnership with state and local governments through federal aid and federal regulatory programs (transportation, for example). Some are equally applicable to federal

TABLE 3-1: PRINCIPAL RELATIONSHIPS BETWEEN PUBLIC PURPOSES AND GEODATA

Public Purposes Relying on Geodata	Major Types of Geodata													
	Geodetic	Cadastral	Political Boundaries	Base Cartographic/Elevations	Bathymetric	Geologic	Hydrography	Transportation and Utilities	Soils	Vegetation	Wetlands and Wildlife Habitat	Cultural and Demographic	Digital Orthoimagery	Statistical Base Maps and Address Files
1. Property Rights and Voting Rights	■	■	■	■	■		■	■				■		■
2. Revenues from Property	■	■	■	■	■	■	■	■		■				■
3. Transportation, Navigation, and Commerce	■		■	■	■	■	■	■			■	■	■	■
4. Public Land and Marine Sanctuary Management	■	■	■	■	■	■	■	■	■	■	■	■	■	■
5. Agricultural and Natural Resource Development	■	■	■	■		■	■	■	■	■	■		■	
6. Environmental Protection and Ecosystem Management	■	■	■	■	■	■	■	■	■	■	■	■	■	■
7. Community and Economic Development (including utilities, housing and public works)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
8. Emergency Management	■	■	■	■	■	■	■	■	■	■		■	■	■
9. Public Service Delivery (including health, education, social, criminal justice, etc.)	■	■	■	■				■				■		■
10. National Defense	■		■	■	■			■					■	
11. Earth System Sciences and GI Technologies	■			■	■	■	■	■	■	■	■		■	
12. Public Information	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Source: Compiled by Academy staff from multiple federal agency briefings and documents, and from other sources.

Geography-based Public Purposes and GI Roles

TABLE 3-2: THE INTERGOVERNMENTAL NATURE OF GEODATA FOR GEOGRAPHY-BASED PUBLIC PURPOSES

Public Purposes Relying on Geodata	Typical Geodata Roles of Different Governments			
	Federal	State	Local	Other
1. Property Rights and Voting Rights	▪ Provide Geodetic Control ▪ Maintain PLSS ▪ Resolve Property Disputes involving federal lands and state lines ▪ Provide Census Data for Reapportionment	▪ Set standards for tax mapping ▪ Reapportion Federal and State Election Districts ▪ Resolve property disputes	▪ Map land parcels ▪ Record land surveys ▪ Reapportion local election districts ▪ Resolve property disputes	▪ Nature Conservancy Groups ▪ Public Advocacy Groups
2. Revenues from Property	▪ Collect Federal revenues	▪ Collect state property and severance taxes and royalties	▪ Assess and collect local property taxes	
3. Transportation, Navigation, and Commerce	▪ Set planning requirements/fund GIS ▪ Supply GI ▪ Require GI reporting ▪ Supply Navigation Reports	▪ Prepare required plans ▪ Collect/report GI ▪ Develop GIS ▪ Use CAD to design and construct roads	▪ Prepare required plans ▪ Collect/report GI ▪ Develop GIS	▪ Prepare metro plans ▪ Collect/report GI ▪ Develop GIS
4. Public Land and Marine Sanctuary Management	▪ Survey Federal Lands ▪ Provide GI for managers and users	▪ Survey State Lands ▪ Provide GI for managers	▪ Survey Local Lands ▪ Provide GI for managers ▪ Provide maps for users	▪ Survey Special District Lands ▪ Provide GI for managers ▪ Provide maps for users
5. Agriculture and Natural Resource Development	▪ Supply Soil, Timber, and Ecological maps ▪ Supply Water Resources maps	▪ Soil and timber maps ▪ Mineral Industry maps ▪ Watershed maps ▪ Fish and Wildlife maps	▪ Economic Development Statistics	▪ Soil conservation plans
6. Environmental Protection and Ecosystem Management	▪ Require plans and compliance with federal standards (permits) ▪ Supply GI ▪ Require GI reporting	▪ Plan/regulate to meet federal standards (permits) ▪ Collect/report GI	▪ Plan/comply with federal standards (permits) ▪ Collect/report GI	▪ Plan/comply with federal standards ▪ Collect/report GI

TABLE 3-2 (continued)

Public Purposes Relying on Geodata	Typical Geodata Roles of Different Governments			
	Federal	State	Local	Other
7. Community and Economic Development (including utilities, housing, and public works)	▪ Require state, regional, and local development planning ▪ Fund GIS ▪ Provide GI	▪ Prepare development plans ▪ Develop GIS ▪ Report GI	▪ Prepare development plans ▪ Develop GIS ▪ Report GI ▪ Regulate geographic development (permits)	▪ Prepare development plans ▪ Develop GIS ▪ Provide infrastructure to support geographic development
8. Emergency Management	▪ Require/fund preparedness plans ▪ Provide GI for response	▪ Prepare required plans	▪ Prepare required plans	▪ Volunteer fire and rescue forces coordinate with others
9. Public Service Delivery (health, education, social, criminal justice, etc.)	▪ Require efficiency and governance equity in funded services	▪ Prepare plans to meet federal geographic requirements ▪ Be accountable for geographic results	▪ Prepare plans to meet federal geographic requirements ▪ Accountability for geographic results	▪ School finance equity ▪ Comparative performance reporting
10.National Defense	▪ Compile Domestic GI for military and anti-terrorist forces	▪ National Guard uses same GI ▪ State supplies GI	▪ Local emergency forces use same GI ▪ Local governments supply GI	▪ Local entities supply GI ▪ Local utilities use same GI as others
11.Earth System Sciences and GI Technologies	▪ Fund and disseminate geographic research ▪ Develop new technologies ▪ Maintain expertise	▪ State universities perform geographic research ▪ Use latest geographic technologies and research results	▪ Use latest geographic technologies and research results	▪ Use latest geographic technologies and research results
12.Public Information	▪ Provide public access to GI	▪ Provide public access to GI	▪ Provide public access to GI	▪ Provide public access to GI

Source: Compiled by Academy staff from multiple federal agency briefings and documents, and from other sources.

agencies and the state and local governments (ecosystem management, for example). Some also apply to the private sector (agriculture, transportation, property rights, and environmental protection, for example). State and local governments and utilities pursue additional public purposes that serve citizens directly.

Thus, the need for GI cascades across the three levels of government and the private sector, sometimes as a result of public purposes enacted by the federal government. Some of the federal agencies responsible for the geography-based federal-aid and federal regulatory programs are funding significant shares of the geodata needed by state and local governments. Some provide GI to their state and local partners directly to help them be more effective in assisting the federal government achieve its legislated goals. These agencies, in effect, are helping to pay for many state and local GI systems and are supplying many CD-ROMs to help achieve their public purposes.

The bottom line is that the federal government is currently involved in many high-profile and important public purposes and missions that rely heavily on GI. These missions are important to the efficient operation of large segments of the U.S. economy, including: real estate, construction, transportation and world trade, public works and utilities, minerals and oil development, forestry, agriculture, community and economic development, and the insurance industry (reducing losses from disasters and providing disaster assistance to supplement private insurance coverage). Widespread public availability of related GI assists in the effective and efficient accomplishment of these missions.

As Table 2-1 in Chapter Two shows, the relationships between geography-based public purposes and the national economy are strong. In part, this answers the first central question posed to the Academy in the contract for this study: "Is GI acquisition, analysis, and distribution critical to keeping the United States competitive in a global economy?"

Table 3-2 makes it clear that the federal, state, local, and other governments are frequently working with similar types of GI to meet similar public purposes. Sometimes there are direct relationships in sharing this information or directly meeting federal requirements by acquiring and using this information; examples occur in federal-aid and federal regulatory programs, and in joint data-development agreements. In other instances the data interrelationships are less clear.

A SUMMARY OF FEDERAL AGENCY AND OTHER GOVERNMENTS' INVOLVEMENT IN GI-BASED PUBLIC PURPOSES

Referring back to Table 3-1, it is possible to trace a complex set of relationships between the federal agencies and state-local governments responsible for the principal GI-based public purposes and the federal agencies that have the lead for producing and/or coordinating the 14 major types of geodata. These responsibilities for public purposes and related data types are set forth below. Then, a summary of state and local government capabilities for dealing with GI is presented. Additional detail, on these relationships may be found in Appendix I.

Agencies and Governments Involved in Major Public Purposes

Property Rights and Voting Rights

BLM has principal responsibility for the Public Land Survey System (PLSS). That system provides a framework for much land law and local land records located in counties throughout the nation, except in the area generally located within the original 13 colonies, Texas and Hawaii.

Voting rights come under the jurisdiction of the Department of Justice, the Federal Elections Commission, and the courts. Voting rights also are governed by state laws and changes to the boundaries of voting districts resulting from reapportionment after each U.S. census. In addition, changes in local government boundaries affect the various officials that voters may elect.

Revenues from Property

BLM and the Forest Service, among other federal agencies, share a portion of the revenues they collect from users of their lands with the states and counties in which the federal lands are located. In addition, many state and local governments collect real estate property taxes from private land owners within their jurisdictions. These revenue-collection activities create the need for comprehensive and accurate property maps.

Transportation, Navigation, and Commerce

Department of Transportation (DOT) assists in the construction, maintenance, and operation of many of the nation's highways, bridges, transit systems, railroads, waterways, ports, and airports. ACE develops and operates many of the facilities on the nation's inland waterways, and has dredging responsibilities for many channels associated with major U.S. ports. In addition, NOS supplies the nation's air and water navigation charts, and DOT controls the nation's airways.

Most of the nation's transportation facilities, however, are owned and operated by state and local governments or special public authorities. A few are privately owned and operated; others are operated by private companies but owned by the public.

Public Land, Minerals, and Marine Sanctuary Management

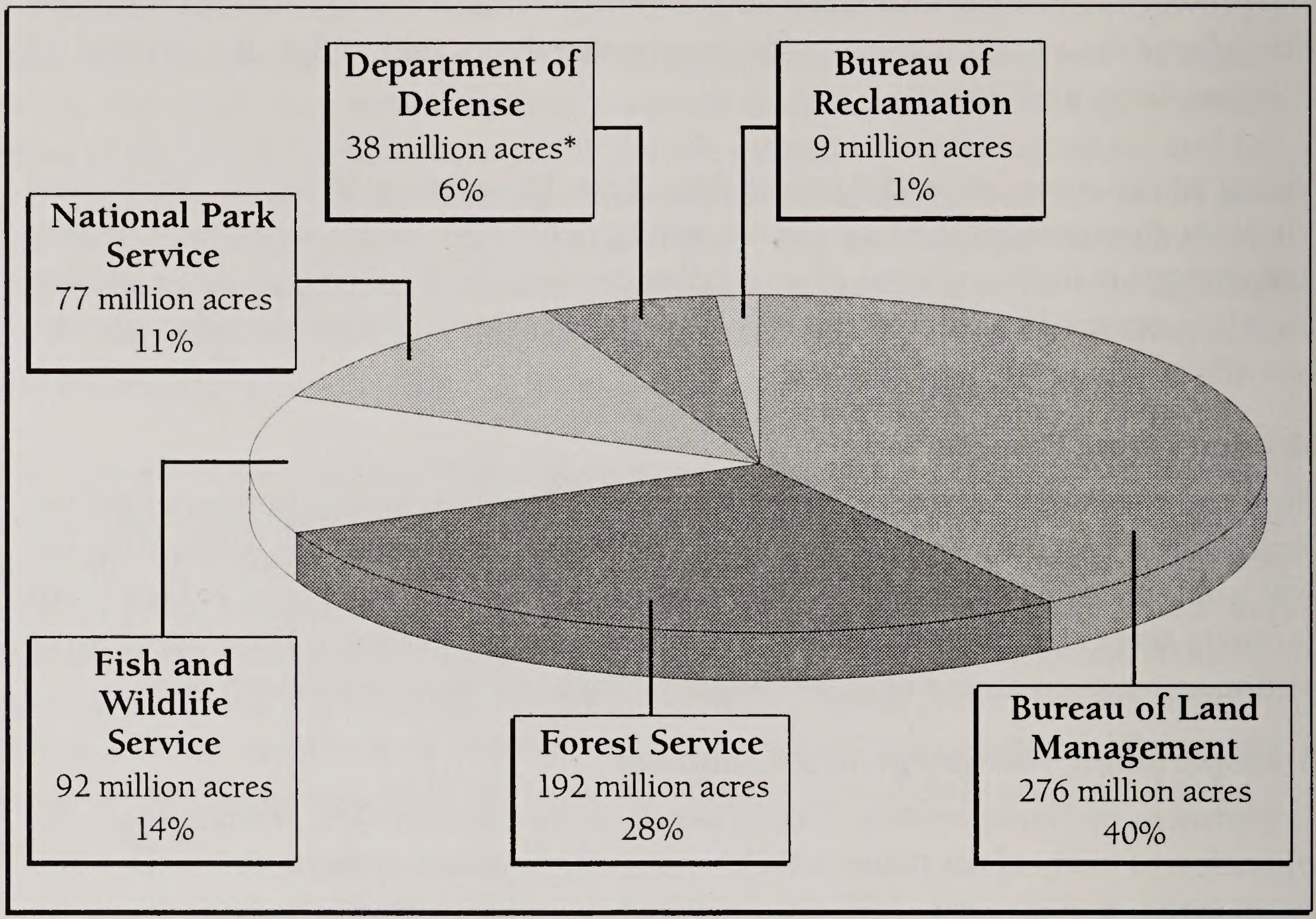
The principal federal land management agencies manage about one-third of the nation's land, and they manage mineral rights on a great deal of former public-domain lands that have been transferred to other owners.

Figure 3-1 shows the relative amounts of land managed by the principal federal land management agencies. NOAA also manages the National Marine Sanctuaries. In addition, a state-NOAA partnership exists to manage the National Estuarine Reserves System (NERRS), and coastal zones under the Coastal Zone Management Act.

State, tribal, and local governments also own and manage substantial acreage of parkland, forest, and other open spaces, some of which is intermingled with federal lands. State lands occupy about 7 percent of the nation, and tribal lands total about 4 percent.

There are substantial similarities among the land management practices and data needs of federal, state, tribal, and local land management agencies, particularly in rural

FIGURE 3-1: RELATIVE SHARES OF PUBLIC LANDS: SIX LARGEST FEDERAL LAND MANAGEMENT AGENCIES



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*Twenty-six million acres of military lands added to DoD Corps of Engineers' civil works holdings of 12.4 million acres.

Source: U. S. General Accounting Office, *Land Management Agencies: Major Activities at Selected Units Are Not Common Across Agencies*. (Washington, DC, June 1977.)

areas. As the emphasis has moved away from short-term profit-maximizing uses of natural resources toward sustainable long-term uses, the need for management information has grown much more complex.

Agriculture and Natural Resource Development

USDA and DOI have large numbers of programs that promote improved agricultural practices and the use of the nation's soil, timber, mineral, water, and recreational resources by farmers, private entrepreneurs, and other government agencies. Many of these programs are administered in cooperation with counterpart state and county governments.

Environmental Protection and Ecosystem Management

The nation's pollution-control and nature-conservation goals are largely set by federal law, and they apply to federal, state, local, and private parties. In some cases, state laws provide even greater protections. The primary programs are clean water, safe drinking water, clean air, solid and toxic waste management, wetlands protection, and endangered species protection.

The primary federal departments and agencies involved in these activities include EPA, NOAA, USDA, and DOI. Sometimes, these agencies work through state counterpart agencies.

Community and Economic Development

This set of public purposes includes urban and rural housing, community facilities, utilities, and business development. The principal federal agencies involved include HUD, USDA, VA, the Department of Commerce, the Small Business Administration, and the Department of Energy.

State governments are involved in many of these programs, but the governments with principal responsibilities are largely local – city, county, and special district. Significant planning assistance is supplied in many cases by regional planning organizations.

Emergency Management

The principal federal agency for coordinating federal responses to public and private parties in times of flood, hurricane, tornado, earthquake, major civil disturbance, or other emergencies is the Federal Emergency Management Agency (FEMA). FEMA is assisted by other federal agencies. For example, USGS provides considerable assistance in earthquake prediction and in real-time early detection and monitoring of fire and volcanic hazards.

FEMA provides assistance to state and local governments to prepare them for such emergencies, and coordinates federal responses when appropriate from 27 other federal agencies. The insurance industry and numerous private agencies, such as the Red Cross, also are part of the response mechanism.

Emergency management activities take place primarily at the state and local levels. Local emergency preparedness activities are critical in dealing with many hazards, such as hurricanes.

Public Service Delivery

The federal government assists state and local governments, and many nonprofit organizations to deliver a wide variety of health, education, social services, and criminal justice services to the nation's citizens. The principal federal departments involved in these programs are the departments of HHS, HUD, Labor, Education, and Justice. For the most part, they work through counterpart state and local agencies.

National Defense

For overseas operations, the DoD unilaterally acquires the needed GI. For GI within the United States, DoD relies largely on the domestic agencies (EPA, FEMA, HUD, NOAA, USGS, etc.).

Earth System Sciences and GI Technologies

The basic computer, Internet, global-positioning, and remote-sensing technologies are revolutionizing the GI field. Civilian research efforts by federal agencies such as the Forest Service, NASA, USGS, NOAA, and NRCS, have enhanced this basic knowledge and made it more widely available to a diverse range of civilian users. Many of the nation's universities and entrepreneurs in the computer hardware and software industries have assisted this effort. The National Science Foundation (NSF) has funded GI Centers of Excellence.

Public Information

The federal government has been a prime source of GI for the public, the business community, and other commercial and public mapmakers since the beginning of the nation. Maps, photos, satellite images, and air and water navigation charts are among the products that are currently available from federal agencies. Some are distributed free, while others are priced modestly to recover the costs of reproduction and distribution. The principal federal agencies offering such products are USGS, BLM, the National Park Service (NPS), the Forest Service, Bureau of Reclamation, the Fish and Wildlife Service (FWS), NRCS, NOAA, and ACE.

State and local governments also supply numerous maps to their citizens to meet the needs of the recreation and driving publics. Examples include maps of state parks, historic sites, and state highway systems. In addition, numerous types of maps related to local government and regional planning processes are being supplied to facilitate improved public-involvement processes, many of which are required by federal-aid programs.

Increasingly, these products are being supplied in digital formats that are more current and can be used more effectively by the public to interact with governments and to satisfy private needs.

Federal Responsibilities for Major Types of Geodata

Referring again to Table 3-1, it can be seen that each of these public purposes relies on many types of GI. For purposes of creating the NSDI, OMB Circular A-16 and a 1994 executive order have established responsibilities for standards for each type of data to particular federal agencies. Thus, any cluster of federal, state, and/or local agencies involved in pursuing a given public purpose should expect to have to deal with several different lead federal agencies if the data they need are not already available in a usable form. Table 3-3 provides a list of federal lead agencies for 13 major types of geodata.

TABLE 3-3: FEDERAL LEAD AGENCIES

Framework Data	Thematic and Other Data
▪ Geodetic Control (NOAA) ▪ Cadastral (BLM) ▪ Political Boundaries (Census/USGS) ▪ Elevations (USGS) and Bathymetry (NOAA) ▪ Hydrography (USGS/NOAA) ▪ Transportation (DOT/NOAA) ▪ Digital Orthoimagery (USGS)	▪ Geology (USGS) ▪ Soils (NRCS) ▪ Vegetation (NRCS) ▪ Wetlands and Wildlife Habitat (FWS) ▪ Cultural and Demographic (Census) ▪ Statistical Base Maps and Address Files (Census)

Source: FGDC.

Summary of State and Local GI Capabilities

State GI activities have been surveyed fairly extensively, but such activities in local governments have been surveyed only partially. Here is a brief summary of what is known about these activities to date.

State GI Capabilities

Most states have public purposes that roughly parallel many of the federal government's GI-related public purposes, and they frequently have similar organizational structures. Examples include: transportation, environmental protection, emergency management, public land management, natural resources development and conservation (including timber, minerals, and water), geodetic control, surveying, land records, fish and wildlife, and a wide variety of public service delivery programs. In many of these cases, direct federal-aid or regulatory links tie these federal and state counterpart agencies together.

In addition, the states regulate private utilities, reapportion election districts as necessary after each decennial U.S. census to maintain the "one-person one-vote" principle, and establish the real estate property tax systems that fund a large share of local government activities.

In recent years, approximately two-thirds of the states have taken steps to modernize tax mapping, land parcel identification, and tax assessment systems, and about 30 states have worked with the National Geodetic Survey (NGS) to help improve geodetic control networks and surveying practices within their boundaries. Wisconsin has been pursuing a notable program in the last few years to improve all of the land records systems within the state.

Public land management is also a significant state function. Together, the states own and manage approximately 7 percent of the nation's land mass (and Indian Tribal governments own and manage another 4 percent) – compared with about 30 percent for the federal government. State land holdings are more substantial in some places than in others. For example, more forested land in the Great Lakes region is owned by state governments than by federal agencies.

Many of the state-managed lands are former national public-domain lands that are managed in trust to provide revenues to support schools, hospitals, higher education programs, and other public functions through resource extraction programs. In recent years, state (and local and private nonprofit) land acquisition programs for open space and conservation purposes have added significant new acreage of nonfederal public lands. It has been estimated that about half of the state land management agencies use modern GIS to help manage their holdings.

Many other state programs produce large amounts of GI. Chief among them are transportation, environmental protection, water and natural resources, forestry, public safety, and emergency management. Some federal agencies, such as DOT and FEMA, are providing digital geographic data to their state counterparts to help meet jointly held public purposes.

Some of the leading states have GI programs that are producing products that meet federal standards. Three examples are North Carolina, Ohio, and Texas, all of which are supplying digital, geographic-data products with cost sharing from USGS that are being incorporated into the USGS series.

Based in part on the new digital mapping technologies that are becoming available, a trend developed in the states during the late 1980s to create GI coordinating groups. This movement is heavily focused on the potential for computerized GIS to integrate data from multiple sources efficiently and mobilize it for addressing multiple governmental tasks. Today, all 50 states have at least one department using GIS, and 42 states have some sort of GI coordinating entity in the executive branch. States have some type of coordinating council, and virtually every type of state agency is represented on at least one council.[4]

Local Government GI Capabilities

Local governments are heavy users and producers of GI. Their traditional products have been property assessment maps, land records, maps of streets and other public works systems, planning maps of many types, and maps used in administering land development regulations. Local governments also are generally responsible for assigning street names and addresses and acquiring and maintaining local parks and open spaces.

Local planning offices have been coordinating GI for many years to improve the comprehensiveness of their planning programs. Increasingly refined federal and state planning requirements have intensified this local activity for nearly four decades. Coordination of GI at the local level has two components: (1) among agencies within a single local government, and (2) among local governments in the same region. As in the states, these coordination efforts are relatively recent. They have been initiated largely initiated as a result of the growing availability of affordable GIS hardware, software, and services in the commercial marketplace.

GIS activity is occurring in all of the nation's metropolitan areas – in part because of DOT's funding of 340 metropolitan planning organizations (MPOs) – and in about half of the nation's 3,043 counties.

A random-sample survey of all urban counties and all municipalities with populations over 25,000 was recently completed by American Forests[5] (1996–97), with cooperation from the National Association of Counties (NACo) and the International City-County Management Association (ICMA). It found that:

- Forty-three percent of the 200 responding cities and counties have an officially designated GIS coordinator.
- Another 35 percent of the jurisdictions have an unofficial coordinator.
- Fifty percent of the jurisdictions have an interdepartmental GI coordinating group.
- Sixty percent participate in a GI coordinating group with another jurisdiction.
- The leading uses of GIS in these jurisdictions were community planning, transportation, utilities, and public safety.

SOME CURRENT CHALLENGES IN MEETING PUBLIC GEOGRAPHIC INFORMATION (GI) NEEDS

Many of the federal missions referred to above require the integration of several types of GI, but many briefings and interviews conducted by project staff indicate that this integration is not always an easy or inexpensive process. Differences in the scales of

TABLE 3-4: SOURCES OF CURRENT TRANSACTION RECORDS RELATED TO MAJOR TYPES OF GEODATA

Major Types of Geodata	Typical Sources of Transaction Records			
	Federal	State	Local	Other
1. Geodetic	▪ NOS Surveys ▪ BLM Surveys ▪ FS Surveys	▪ State and regional networks	▪ County Land Records Offices	
2. Cadastral	▪ BLM ▪ Forest Service		▪ County Land Records Offices	
3. Political Boundaries	▪ Federal Courts (Voting Rights Act)	▪ Legislature ▪ Secretary of State	▪ Counties	
4. Base Cartographic/ Elevations	▪ USGS ▪ FS ▪ NOS	▪ Geological Surveys ▪ Highway Departments	▪ Local Planning Departments	▪ Regional Planning Organizations
5. Bathymetric	▪ ACE waterway and port depths ▪ NOS tides and currents			
6. Geologic	▪ USGS seismic measurements			
7. Hydrography	▪ USGS stream gauges	▪ Water Rights		
8. Transportation and Utilities	▪ NOAA navigation services	▪ Transportation departments and agencies	▪ City ▪ County	▪ Special District ▪ Private Utility
9. Soils				
10. Vegetation	▪ Satellite imagery			
11. Wetlands and Wildlife Habitat	▪ Corps of Engineers wetlands/industry reports ▪ EPA pollution reports/permits/ emissions reports	▪ Two states have authority to issue wetlands permits ▪ Pollution permits issued by environmental and natural resources agencies		
12. Cultural and Demographic			Local permits for: ▪ Building Construction ▪ Occupancy ▪ Demolition ▪ Condemnation	▪ School Enrollment
13. Digital Orthoimagery				
14. Statistical Base Maps and Address Files	▪ Post Office		▪ Cities ▪ Counties	

Source: Compiled by Academy staff from multiple federal agency briefings and documents, and from other sources.

source data and the lack of established institutions, procedures, and agreements for data sharing and maintenance sometimes cause duplicate data acquisition and digitizing of GI by different users to meet their own immediate needs. Available data sets frequently do not match when overlaid upon one another, and sometimes not all of the needed data exist in digital form. Thus, the simple combination of electronic files is rarely a realistic option.

Representatives of federal agencies such as EPA and FEMA, which are pursuing large GI-integration projects, told project staff that they are finding the amount of effort required particularly challenging. Both are using contractors working with them in-house to get the job done, but the effort is costly and time-consuming.

One reason that many types of GI are out of date and not likely to be updated regularly is the matter of scale. Usually, GI at national scales and nationwide coverage (1:100,000 and 1:24,000, for example) are updated by photogrammetry, rather than by adding new information from other partial, inconsistent, and piecemeal sources – such as transaction data from local governments where new streets and new buildings have been built in accordance with locally issued permits. Simply waiting for the next update cycle to come, however, allows national maps to become far out of date. This has occurred, in some cases even when state and local data with the potential to update federal files has been offered to the federal government in digital form at the federally specified level of resolution and detail.

Table 3-4 shows some federal, state, and local sources of typical transaction data that might be used to update GI databases for 11 of the 14 major types of data listed in Table 3-1. The potential nonfederal update sources for a 12th type – base cartographic – are not actually "transaction" data in the same sense as for the other data types, but rather concurrent mapping programs that could and, in some cases are, being taken advantage of to create new maps more frequently than USGS could produce them using its own resources alone.

Varying purposes and varying scales of photogrammetry and mapping also separate the federal agencies from each other, and separate state and local governments from federal agencies. At the present time, it is difficult to bridge the gaps in purpose, scale, and level-of-detail, but some federal agencies have gone a long way to overcome it. Agencies and governments with different scale needs sometimes go their separate ways – ordering additional sets of photogrammetry, drawing new maps, and digitizing the same territory again for their own purposes.

"Generalization software" is the hoped-for solution to the problem of multiple scales. Although it is being worked on, usable versions are not yet available. Meanwhile, federal agencies such as the ACE, NRCS, BLM and the Forest Service work with large-scale maps that are appropriate for project design and cooperation with local governments, survey crews, cost-sharing project co-sponsors, or farmers. Many other federal agencies work with much smaller scales appropriate for more general use by planners and recreationalists. With no "right scale" or level of detail for use by everyone, and no practical way of translating accurately between the different scales, some duplication is inherent in the different uses of GI that are being made.

GEOGRAPHIC INFORMATION ROLES MOST APPROPRIATELY PROVIDED BY THE FEDERAL GOVERNMENT

The preceding review suggests that the following three roles in providing GI may be most appropriate for the federal government:

- ensure GI availability to support federal policymaking and operational responsibilities
- ensure that federal GI requirements imposed on, state, local, and tribal governments are reasonably attainable and consistent
- help improve GI data quality, coverage, and accessibility to benefit an expanding array of users through national standards, a national clearinghouse, data archiving, and basic geoscience support.

The first two of these federal roles are focused on meeting current needs, while the third focuses on ensuring the nation's long-term competitiveness and leadership by helping to keep GI practices in the United States at the cutting edge of technological and public policy innovation.

This is an ambitious array of federal roles that may be described as follows.

GI to Support Federal Policymaking and Operational Responsibilities

The constitutionally enumerated roles of the federal government that rely on GI obviously are important. These include managing federal property and property boundaries, providing for a nationwide framework for cadastral surveying, assisting interstate and foreign commerce with accurate navigation charts tied to a reliable geodetic control system, providing for the national defense, and providing a decennial census to allow the proper apportionment of voting districts. Derivative federal geo-based policy goals, not directly enumerated in the Constitution, include emergency management, wetlands permitting, and payments in-lieu-of taxes (PILT) that share federal land revenues with the states and counties where they are derived. The federal government also has responsibility for representing the nation in international standard-setting for GI.

With the exception of managing the federal lands and administering the payments in-lieu-of taxes, these policy areas require nationwide GI. Even the geographically limited goal of managing the federal lands increasingly is requiring ecosystem-wide GI that often ranges well outside the federal property itself.

GI to Help State, Local, and Tribal Governments Meet Federal Requirements

The following geography-based activities are intergovernmental partnerships established by federal law: transportation planning, community and economic development planning, environmental regulation, public service delivery of numerous types, and emergency management planning and operations. In the first two activities, federal funds frequently pay for establishing and maintaining GI systems and require that these GI data be made available to the populations served as well as to the federal government. In the environmental and emergency management programs, the responsible federal agencies are developing automated GI systems to assist their intergovernmental partners in doing a better job.

Since these are nationwide programs in which numerous governments and populations participate, the GI systems serving them are virtually nationwide and freely available. Putting this data in the public domain helps to empower the affected governments and populations to have effective access to the public policymaking processes that will determine day-to-day living conditions. Public access to these types of data is another side to GIS data sharing (the user side) that has not received as much attention as the data producer side.[6]

Although these federally legislated activities do not have constitutional imperatives behind them, a federal financial responsibility for them could be implied by the fact that most of them are, or were, part of federal-aid programs established by legislation. The exceptions are in the environmental regulation field where former federal aid levels have been reduced or were never available. But, it was the growing imbalance between federal aid and unfunded federal regulations that led Congress to enact the Unfunded Federal Mandate Reform Act of 1995, which attempts to limit that practice. Nevertheless, state, local, and tribal governments remain responsible for collecting and using required GI appropriately, whether or not the federal government provides adequate assistance.

Improved GI Quality and Accessibility

One of the most important keys to improving GI quality and accessibility—not counting funding—is commonly accepted and used standards. Several types of needed standards have been identified by FGDC and are being developed or already are in use. The functions that standards perform include (a) providing for appropriate classification and measurement of each kind of GI, (b) recording the location of the data accurately so it can be overlaid on other data sets for integrated use, (c) updating the data, (d) transferring the data among diverse users and software applications, and (e) facilitating the ability to print maps and tables on demand. Such standards can help to facilitate full use of the emerging GI technologies in the pursuit of established public policy goals. Standards are discussed in greater detail in Chapter Four.

The federal government has an important role in basic research and in transferring new technologies that originate in federal labs into the domestic economy. Federal agencies perform both of these roles under a variety of laws,[7] and provide many benefits to the GI field. The purpose of these laws is to spur the U.S. economy's competitiveness in the world economy and to realize available returns to the U.S. economy from federal investments. The federal government funds basic research in fields such as geology, seismology, geodesy, hydrology, and ecology, and has a long track record in developing underlying technologies such as satellites, remote sensors, GPS, and the Internet. Finally, both the science and the practice of GI need complete, accessible, and secure archives of historical data files such as those maintained by USGS.

These three federal roles in GI, described above, present a tall order for the federal government to fill by itself. It needs help from the state, local, and tribal governments, and from the private sector. It is, in fact, already getting that help in many ways.

PANEL FINDINGS CONCERNING APPROPRIATE GEOGRAPHIC INFORMATION (GI) ROLES

Federal Roles

The federal government is pursuing a wide variety of well-established public purposes that require GI for their proper performance. These public purposes include:

- PLSS – to provide for the orderly management, sale, and transfer of the national public domain lands
- **horizontal geodetic control and elevations** – to enable accurate location of points on the surface of the earth
- **public land management** – constituting one-third of the nation's lands; these lands are managed by several federal agencies for (1) sustained yields of timber, energy, water, offshore oil and gas, and mineral resources through leases to private companies, (2) ensured environmental and ecological protection, (3) recreational uses, (4) protection of endangered species and wildlife habitats, and (5) protection of national marine sanctuaries.
- **population census, voting rights, and reapportionment** – requiring census maps
- **international and interstate commerce and transportation** – including air and water navigation charts
- **postal delivery** – requiring street maps and mailing addresses
- **national defense** – to enable mobility of the military within the U.S. and to points of overseas embarkation, and management of military installations within the U.S.
- **agricultural and natural resources development** – requiring maps of soils, geological resources, water resources and wetlands, forest resources, grazing lands, recreational areas, and ocean resources
- **environmental protection and ecosystem management** – requiring geographic depiction of land and water based pollution, pollution sources, endangered species, vegetation, wetlands, wildlife, erosion
- **community and economic development** – requiring information about land use, infrastructure, economic activities
- **emergency management** – flood plains, seismic hazard zones, emergency facilities, emergency transportation routes
- **public service delivery** – locations and characteristics of federally supported public program clienteles and service locations
- **historic preservation** – locations and characteristics of historic and archeological sites and historic buildings

The federal government assumes liability for the accuracy of some of the GI it produces, including its nautical and aeronautical navigation charts, its public land surveys, and federal maps used by the public while on federal lands.

The federal government is a source of research funding for both earth sciences and seminal GI-related technologies.

Shared GI Roles

Most of the GI-related public purposes the federal government is pursuing are shared by multiple federal agencies and by state and local governments. Much of the GI currently produced at one level of government is not readily usable by other levels. Many public agencies are expending significant amounts of effort, time, and money to put available GI into forms that they can use to help meet their own public purposes. The efforts of one agency often duplicate those of another. On the other hand, an example of how GI from diverse sources can be combined is provided by the National Geodetic Survey's procedure for other governments and private surveyors to send information about the new control points they establish to NGS to the geodetic control network . A similar procedure exists for updating nautical and aeronautical charts.

Three of the most common differences in the GI needs of different governments are (1) the degree of resolution (or scale and detail) of the data that they require to meet a particular public purpose, (2) the area of coverage, and (3) the currentness of the data.

For example, federal policymaking and tracking the implementation of federal policy goals frequently require information summarized for the entire nation, major regions, and the states. Similarly, policymaking and tracking by states, regional planning and implementation bodies, local governments, and tribal governments frequently require GI that can be summarized conveniently entire jurisdictions and the principal subareas within them.

GI for use by public land managers to cover holdings under their jurisdictions and, increasingly, the ecosystems or watersheds that affect them. They also must have precise property boundary information to delineate their areas of jurisdiction.

GI for project design and management must be detailed and current enough to support the project purposes – whether they are construction, operational, or regulatory.

GI to meet the needs of the general public must be tailored to a variety of uses, such as hiking, camping, sightseeing, boating, producing derivative maps, facilitating public involvement in land-use planning, and enabling public compliance with government regulations. Several different levels of detail and accuracy are needed to meet these diverse requirements.

Separate State, Local, and Tribal GI Roles

State, local, and tribal governments have some needs and purposes served by GI that are separate from those shared with the federal government. Some of the most obvious are:

- land records for nonfederal lands
- property taxation
- local planning, subdivision control, and zoning
- state and local public works and transportation projects not receiving federal aid
- utilities

- management of state, local, and tribal lands
- direct delivery of many public services

Private GI Roles

Private utilities and many private companies need GI similar to that which governments use for planning purposes. Utilities are significant producers of GI as a result of their operations, and they sometimes are willing to swap such information with governments in their areas of operation to gain mutual advantage.

Private companies offering GI services to governments, businesses, and consumers can expect increased business from governments as the need for GI continues to grow and the ability of governments to provide their own GI shrinks.

CONCLUSIONS AND RECOMMENDATIONS

The Panel concludes that:

- Governments have a responsibility to ensure adequate GI to support sound, responsive, and accountable public decisionmaking to effectively and efficiently achieve their public purposes. Several levels of data resolution detail and currency are necessary to meet the full array of established public purposes for all levels of government.
- Governments have a responsibility to make this information widely available and easily accessible to the public, so that the public can have an effective voice in public decisionmaking processes.
- As new technologies become available for improving the availability and quality of GI, governments need to take advantage of those technologies to improve the quality of their decision-support systems.
- Interagency and intergovernmental consortiums and bilateral or multilateral agreements should be encouraged to provide geospatial data to the NSDI in accordance with national standards
- The federal government has a responsibility to ensure the availability of comparable nationwide GI of (a) the types needed to maintain an efficient common base for public GI systems, (b) the types needed to achieve the federal purposes set forth in the Constitution and the laws and regulations of the United States, and (c) the levels of resolution, detail, and currency required to meet multiple federal purposes.
- Ensuring the nationwide availability of these geographic data does not require the federal government to produce all of them itself. Numerous state, local, tribal, and private sources of such data are available, some with higher resolution, greater detail and currency, and lower cost than the federal government could produce by itself. Data sharing arrangements offer potential quality improvements as well as cost savings. In areas where needed GI is not available from other sources, such as some of the national forests, the federal government should continue to be the primary source.
- The keys to ensuring efficient nationwide availability and sharing of the GI from multiple sources are (a) reliable geodetic referencing of data, (b) adequate scale,

content, and format standards, (c) acquisition and maintenance of commonly used and widely accepted data in compatible digital forms, and (d) the continuing capacity, expertise, skill, and engagement of public agencies necessary for them to ensure the quality and accessibility of data from multiple sources.

- The federal government has a responsibility to help to support continued long-term research in the basic earth sciences. Most state and local governments do not have the resources to perform this task, and the private sector has incentives to perform only such research as may have reasonably certain prospects of commercial pay-off. The academic sector performs much of this scientific work with federal funds.
- The federal government has responsibility for providing long-term historical and archival storage of GI, including such items as federal land ownership records, urbanization and demographic trends, natural resources trends, and ecological trends.

Recommendations

The Panel recommends that:

- **In order to help achieve the geography-related public purposes of the federal, state, local, and tribal governments, and public utilities outlined in this chapter, more effectively and efficiently, the federal government should help to ensure full and rapid implementation of the National Spatial Data Infrastructure (NSDI) in a cost-effective and cooperative manner.**
- **Interagency, intergovernmental, and private-sector GI user and producer groups, whose cooperation is essential to implementing NSDI, should continue to be convened to encourage accelerated development, sharing, and maintaining of the NSDI framework data files. These groups should be used to negotiate additional data sharing and joint funding agreements. These groups and agreements should address the following key success factors of NSDI: (a) reliable geodetic referencing of data, (b) adequate content and format standards, (c) acquisition of commonly used and widely accepted data in compatible digital forms, and (d) the continuing capacity, expertise, skill, and engagement of public agencies necessary for them to ensure the quality of data from multiple sources.**
- **The potential for using geographic-referenced data from government and private transactions to maintain nationwide GI databases should be exploited whenever appropriate and cost-effective, to ensure that the most current information is incorporated into the NSDI.**
- **Interagency and intergovernmental consortiums should be encouraged to become increasingly important providers of geospatial data to the NSDI, following national standards.**
- **The federal government should support long-term, interdisciplinary research by universities and others on GI technologies, earth sciences, and related topics, consistent with encouraging private sector initiatives. Priorities for such research should include, but not be limited to programs to develop: (1) practical generalization software to translate between scales; (2) techniques for utilizing satellite imagery to enable rapid updating of GI data files and maximum analytical use of this new source of massive amounts of GI with-**

out overwhelming the system; (3) easy-to-use automated techniques for updating base data with current transaction data; and (4) software for merging and harmonizing geographic data files from diverse sources.

ENDNOTES

[1] See Special Analysis 2 in Appendix I of this report.

[2] See the Policy Base issue discussion in this report.

[3] President's Council on Sustainable, p. 59.

[4] Lisa Warnecke, *Geographic Information/GIS Institutionalization in the 50 States: Users and Coordinators.* (Santa Barnara, CA: National Center for Geographic Information and Analysis, September, 1955), p. 12.

[5] Lisa Warnecke, Jeff, Beattie, Cheryl Kollin, and Winifred Lyday, *Geographic Information in Cities and Counties: A National Assessment,* (Washington, DC: American Forests, forthcoming.)

[6] Jack Dangermond, "Public Data Access: Another Side of GIS Data Sharing," in Harlan J. Onsrud and Gerard Rushton, eds., *Sharing Geographic Information.* (New Brunswick, NJ: Center for Urban Policy Research, 1955), pp. 331-339.

[7] See for example: Stevenson-Wydler Technology Innovation Act of 1980; Federal Technology Transfer Act of 1986; Omnibus Trade and Competitiveness Act of 1988; and National Technology, Transfer and Advancement Act of 1995.

CHAPTER 4

Providing National Leadership and Coordination for the NSDI

The federal government did not consolidate its GI functions as recommended by the OMB task force in 1973 and the NRC in 1981, and has chosen instead the path of consensus through coordination, standards-setting, and cooperation to improve efficiency, contain any overlap and duplication, and build the NSDI. This strategy requires effective leadership and coordinating mechanisms at all levels of government if the NSDI ideal described in Chapter Two is to be achieved. Therefore, the Academy Panel addressed the following question:

> *Do OMB Circular A-16 on operations of the Federal Geographic Data Committee and Executive Order 12906 on the National Spatial Data Infrastructure provide sufficient policy and institutional bases for setting standards, integrating federal activities, and coordinating with other governmental and private-sector activities?*

This chapter discusses the GI leadership roles of the President, Congress, and the secretary of the interior; summarizes federal, state, and local government coordination initiatives; identifies the need for a national coordinating body; and reviews the processes of standards development, adoption, and implementation.

In summary, the Panel finds that OMB Circular A-16 provides a reasonably sound and useful charter, and it was reinforced by Executive Order 12906. However, they are federally focused. Interagency, intergovernmental, and intersector coordination and cooperation are not mandated. These functions of coordination and cooperation have no statutory base. A few organizations representing state and local governments are now participating in FGDC. This is a useful step toward building an NSDI, but state and local governments are not full partners with the federal government under the committee's present charter. Participation by the private sector is also limited. A new public-private organization is needed to supplement the FGDC and perform tasks in a businesslike manner.

NATIONAL LEADERSHIP

National leadership for GI functions and activities has been exercised primarily by the federal government through the efforts of individual federal agencies and coordinating bodies, such as the FGDC, although state and local government organizations, professional societies, and industry groups have also played key roles. At the federal level, the secretary of the interior is the most senior official with continuing policy responsibility for GI. The Executive Office of the President and Congress also weigh in from time to time to set broad policy goals and provide guidance on specific initiatives and funding levels. The panel sees a need for strong and continuing leadership to coordinate individual agency activities, to expand cooperation with other levels of government and the private sector, and to achieve the goals of the NSDI.

Executive Office of the President

GI is not a topic that gets much attention in the Executive Office of the President. Expenditures for mapping, charting, geodesy, and other GI-related activities are relatively small, and funding for them has been either fairly stable or declining in recent years. The associated policy issues have not been of sufficient urgency or magnitude as to warrant presidential attention. While GI is considered a subset of all electronic information, no one in OMB, its Office of Information and Regulatory Affairs, or other White House offices has been active in effectuating this linkage. Nevertheless, the NPR headed by Vice President Al Gore provided some prominence to the NSDI concept in its supplemental report on the Department of the Interior. The report stated:

> The federal government has a unique opportunity to coordinate and manage partnerships with private industry and state and local governments to develop what promises to be one of the most important information technologies of the 21st century, the national spatial data infrastructure . . .
>
> These digital maps of the future will be essential to analyze and depict environmental information . . . and, more generally, hydrology, soils, agriculture, climate, geology, transportation, and urban development through the United States. NSDI will play an integral role in the Administration's information infrastructure investment and information highway.[1]

The report recommended a series of actions, including a strengthening of the FGDC charter, a program to form partnerships with state and local governments and the private sector, collection and production national core geospatial data by the year 2000, and creation of a geospatial data clearinghouse. FGDC was also asked to participate in an OMB-led budget crosscut, that is, a governmentwide budget for geospatial activities for fiscal year 1995 to assure a coordinated and coherent federal effort.

After the NPR report and issuance of the executive order, the White House and OMB deferred to the FGDC to coordinate federal GI functions. OMB examiners do not have the capability to track surveying, mapping, and GI activities in any detailed fashion. (OMB is organized along functional lines in resource management offices, but budget examiners generally track individual agencies; there is little capacity for crosscutting analyses.) The budget crosscut recommended by the NPR never occurred, and no one is comprehensively assessing the roles, responsibilities, activities, or expenditures of agencies engaged in GI activities. Pressure for change has come largely from Congress to downsize and outsource.

Congress

Interviews with congressional staff and the inventory of legislation addressing GI issues indicate that congressional interest in GI has been modest in recent years. The last major piece of legislation affecting civil agencies, the Geologic Mapping Act, was passed initially in 1992. Other legislation, such as the deficit reduction acts, have affected funding for federal GI programs, but routine management and funding issues are dealt with annually through the appropriations process. MAPPS has been active in encouraging privatization and outsourcing of GI functions, and the House Appropriations Committee has set multi-year percentage targets for USGS outsourcing. Another interest, according to one Appropriations Committee staffer interviewed for this study, is primarily focused on overlap and duplication among GI programs and agencies.

Proposals made early in the 104th Congress to abolish the Department of Commerce as well as the USGS got the attention of the federal GI community and contributed to efforts to undertake this Academy study, but interest in passing such legislation has waned considerably over the past two years. The most significant legislation enacted into law was that creating NIMA.

In the 105th Congress, a bill was enacted to extend the National Geologic Mapping Act authority (P.L. 105-36), and legislation has been introduced to encourage private-sector provision of goods and services needed by government to perform its missions (S. 314). This bill, titled the Freedom from Government Competition Act, would essentially require that all goods and services, including GI-related goods and services, are to be outsourced unless they are inherently governmental or should be provided in-house for reasons of national security, best value, or because private-sector sources are inadequate to satisfy an agency's requirements. No legislation has been introduced dealing broadly with GI.

Secretary of the Interior

FGDC has been fortunate to have a cabinet secretary heading it with expertise and interest in GI. Even so, as FGDC chairman, Secretary Babbitt has no formal authority over his fellow committee members. He also has no means to compel attention by political leaders at the state and local levels. While such officials would show respect for the secretary's high office, they have their own constitutional and statutory mandates to guide their actions.

Secretary Babbitt has regularly chaired the FGDC steering committee, and he has chosen a low-key style designed to keep GI out of the sometimes contentious politics surrounding federal environmental and land-management issues. FGDC has made reasonable progress with this mandate, due in part to the interior secretary's knowledge, interest and energy. However, continuity of leadership is contingent on his longevity in office – even now well above the average tenure of cabinet secretaries – and the willingness of his successor to assume a similar role.

One sponsoring agency official observed that the FGDC's progress to date also has depended in large part on the energy of "hundreds of interested individuals and agencies working daily on activities which support the FGDC and the NSDI."

Conclusions

- With interest and leadership by a cabinet secretary and support by participating agencies, FGDC has made progress toward creating the NSDI, but the committee plays primarily a coordination role.
- Good progress is being made by FGDC on the federal agenda, but the pace can and should accelerate on a national agenda.
- Implementation is essential to the success of the NSDI concept and is the responsibility of the agencies.
- The momentum and progress achieved to date requires high-level leadership and expertise in GI.
- Strong OMB leadership is needed to address and resolve matters such as reconciling the roles and responsibilities of agencies active in GI and encouraging agency implementation of the framework and standards developed by the FGDC.

FEDERAL GEOGRAPHIC DATA COMMITTEE (FGDC)

Presidential administrations since the 1950s have recognized the need to coordinate the GI functions and activities of the many federal civilian agencies providing surveying, mapping, and GIS functions. In 1990, the FGDC was established for this purpose as the successor to an earlier interagency coordinating committee for cartography. The FGDC was charged with the responsibility to coordinate various surveying, mapping, and spatial data activities of federal agencies to meet the needs of the nation. Major objectives of Circular A-16 are to enhance coordination, thereby avoiding duplication and reducing costs in mapping and spatial data activities, by establishing standards and providing wider access to geospatial data. The FGDC also has been charged with coordinating geospatial data-related activities with other levels of government and with public, private, and academic sectors.

Through numerous subcommittees and task forces, FGDC pursues a diverse agenda of initiatives on standards-setting, interagency cooperation, and information dissemination. FGDC subcommittees work on issues related to data categories coordinated under the circular. Subcommittees establish and implement standards for data content, quality, and transfer; encourage the exchange of information and the transfer of data; and organize the collection of geographic data to reduce duplication of effort. Working groups are established for issues that transcend data categories.

The FGDC Steering Committee, chaired by Secretary Babbitt, meets quarterly. The Coordinating Group and the Standards Working Group, composed of senior-level career officials, meet monthly. The FGDC is composed of representatives from the departments of Agriculture, Commerce, Defense (ACE and NIMA), Energy, Housing and Urban Development, Interior, State, and Transportation; the EPA; FEMA, the Library of Congress; NASA; the National Archives and Records Administration; TVA; and the National Science Foundation. Additional federal agencies participate as members of FGDC subcommittees and working groups. Such meetings are also open to state/local and private-sector representatives.

In late 1996, one representative each from the National State GI Committee (NSGIC) and the National Association of Counties (NACo) were added as non-voting members to provide representation for state and local government. There are no private-sector or academic members, although informal ties have developed with the Open GIS Consortium and the University Consortium for GI Sciences (UCGIS). The National League of Cities (NLC) is also being added to the Steering Committee.

Participation by state and local government organizations is a useful step toward building an NSDI, however, under the committee's present charter they are not full partners with the federal government. Also, NSGIC and NACo do not represent the full range of state and local governments and they do not have the clout to significantly influence the actions of such governments or their agencies across the United States. Neither academia nor the private sector are formally represented, except as members of a recently organized stakeholders' group.

Federal agencies active in FGDC also do not reflect the full range of federal agencies active in GI and some FGDC members are not fully active. Federal attention on GI historically has focused on natural resources missions and data, but GI and GIS use is growing in many new areas such as public safety, health and human services, and infrastructure. The agencies have differing perspectives and needs, and some have greater potential than others to use GI and GIS to enhance effectiveness and reduce program costs. Also, the challenge of shifting from the cartography focus of the predecessor coordinating committee to the full range of GI acquisition and production initially inhibited the full consideration of other technologies, such as satellite imagery, GPS, or tabular geographically referenced data. However, the sponsoring agencies have acquired and now use these technologies extensively. Application of these technologies is being left largely to other coordinating groups so FGDC can focus on the GI issues that need immediate attention.

NIMA, an agency with major funding devoted to GI, is also inactive in some FGDC coordinating activities. The agency, which has no national role and has set its own course to meet defense needs for GI abroad, is not necessarily in harmony with civilian efforts to create a comprehensive and widely used NSDI. NASA, another agency with major GI-related programs, appears to be less involved now than earlier in FGDC. The NSF, a major funder of GI-related research, joined the FGDC in 1997.

FGDC functions as an interagency committee subject to the Federal Advisory Committee Act (FACA), but it operates outside some of its requirements. According to USGS staff, FACA regulations allow full involvement of other governmental organizations in operational federal activities, such as development of the NSDI, but formal involvement of the private and academic sectors probably requires establishment of a FACA advisory committee, a tedious and onerous process. This limits the FGDC's ability to become a "national" coordinating body for GI. So far, the FGDC has finessed the act's requirements by avoiding situations where the act would apply, but its ability to continue doing so conflicts with its encouragement of active participation by non-federal parties.

Federal Advisory Committee Act (FACA) Procedures

- FACA (5 U.S.C., App.) authorized the establishment of a system governing the creation and operation of advisory committees in the Executive Branch of the federal government. Under the act:
- Agencies must establish uniform administrative guidelines and management controls that are consistent with the act and rules of the General Services Administration (GSA).
- Agencies must maintain systematic information on the nature, functions, and operations of their advisory committees.
- Agency heads must designate committee management officers who are responsible for exercising controls and supervision over the committee management program.
- Committees must be chartered before they can meet or conduct any business.
- Charters must be renewed every two years or they will be terminated under the sunset provisions of the act, unless otherwise provided by law.
- Advisory committee memberships are to be fairly balanced in terms of the points of view represented and the functions performed.
- Advisory committee meetings are required to be open to the public, with limited exceptions. Meeting notices and agendas must be published in the Federal Register to accommodate public participation.
- Designated federal officials must approve all meetings and agendas, and attend meetings.
- Detailed minutes are to be kept and must contain: (1) date and location of the meeting, (2) a record of the persons present, (3) a complete and accurate description of matters discussed and conclusions reached, and (4) any advice or recommendations provided by the committee.
- All advisory committee documents must be available for public inspection and copying until the committee ceases to exist.
- Records must be maintained which will fully disclose costs for the purposes of GAO audits and the President's annual report.

Source: GSA course materials.

Budget Constraints

Most federal, state, local, and tribal government agencies are constrained by competing budget priorities in the pace with which they move forward on meeting the goals of Executive Order 12906. In particular, there are costs associated with creating metadata and software and data conversion for legacy data. Some agencies have not yet completed or upgraded their telecommunications infrastructure to support both access and transfer of data via the Internet. This is significant because much of the access to GIS databases and the sharing and transfer of data is done using the TCP/IP protocols over the Internet. As an example of competing priorities, many of the key staff resources and discretionary funding have been redirected to the year-2000 computer problem. The clear impact of such realities is that, in the absence of additional major funding, only part of the highest priority efforts will be implemented and fulfillment of the stated goals for the NSDI is many years away.

FGDC's Competitive Cooperative Agreements Program (CCAP), Framework Demonstration Projects, and the NSDI Benefits Program provide some seed money on a competitive basis to state and local grantees for demonstration projects, but the resources are far short of those needed to create a robust NSDI anytime soon. Many states and localities have limited or no capabilities for GI or GIS and data sets, and the funding required to have them be meaningful contributors to the NSDI far exceeds the federal resources provided so far through these programs. Reallocation of existing resources would be needed or additional funding provided to increase the institutional capacity of these state and local governments, an unlikely prospect given the tax and budget legislation enacted in July 1997. Bringing all parties up to speed will more likely require a joint effort by all levels of government and the private sector.

Progress Being Achieved

FGDC operates with the assumption that the NSDI is not one, agreed-upon set of geospatial data representations for the nation (for example, one road network). The NSDI most likely will include a large collection of multiple representations of geography that meets multiple user needs. Tables 4-1, 4-2, and 4-3 on the following pages summarize the steps taken over the past three years to implement key elements of the NSDI strategy as set forth in E.O. 12906.

There has been substantial progress at this relatively early stage in the implementation of specific actions mandated by Circular A-16, the NPR report, and the executive order, but the overall progress in creating widely used and comprehensive data sets under the NSDI appears to be painfully slow. Most data suppliers and data users are skeptical of NSDI concepts or they do not see sufficient benefit to modifying their own practices for collecting and maintaining data, particularly if it is more costly to implement a federally endorsed standard. Data is still predominantly collected to meet specific programmatic and user needs.

Tasks Not Getting Done

OMB Circular A-16 says the objective of FGDC is to "promote the coordinated development, use, sharing, and dissemination of surveying, mapping, and related spatial data."[2] The stated strategy for accomplishing this was to create a national information resource, that is, the NSDI, linked by criteria and standards, to enable sharing and efficient transfer of spatial data between producers and users through "information partnerships" among government institutions and the public and private sectors, thus avoiding wasteful duplication of effort and ensuring effective and economical management of information resources in meeting essential user requirements. Circular A-16 and E.O. 12906 provide a stronger policy base than existed previously, but they are legally enforceable only by the executive branch of the federal government.

Neither FGDC nor any other central office or coordinating body can require any two or more agencies to work together, much less to consolidate any of their GI functions. Moreover, important segments of federal GI functions are not covered by A-16, including those involving mapping by the national defense community. DoD was designated

TABLE 4-1: NATIONAL SPATIAL DATA INFRASTRUCTURE IMPLEMENTATION ACTIONS FROM EXECUTIVE ORDER 12906, 1994 FGDC PLAN FOR THE NSDI, AND 1997 STRATEGY FOR THE NSDI

A Report Card on Progress

	Actions	Status
Clearinghouse	Take Steps to establish a Clearinghouse. (EO 12906)	June 1994 – National Geospatial Data Clearinghouse established. June 1994 – FGDC guidelines for implementation.
	Adopt Clearinghouse use policy. (EO 12906)	June 1994 – FGDC policy included in Guidelines.
	Ensure effective means for finding, accessing, sharing and using geospatial data. (1994 Plan)	June 1994 – Clearinghouse established and guidelines issued.
	Continue to develop a seamless National Geospatial Data Clearinghouse. (1997 strategy)	1995 – 10 organizations operating clearinghouse prototype. July 1996 – Clearinghouse node with geo-search pilot tested. 1996-97 – Additional implementation assistance provided by FGDC working group and on FGDC web site. 1997 – ISITE Clearinghouse software is operational. July 1997 – 40 compliant clearinghouse nodes in operation. July 1997 – Draft encoding standard for geospatial metadata proposed.
Metadata	Document new data using metadata standards as of January 1995. (EO 12906)	June 8, 1994 – FGDC content standard for digital geospatial metadata. Guidelines and Implementation Workbook for Clearinghouse and metadata provide guidance on documentation.
	Agencies to develop a plan by April 1995 to document existing data (EO 12906)	June 1994 – FGDC guidelines issued. Metadata collection or existing data varies by agency.
	Support the continued evolution of common means to describe geospatial data sets. (1997 strategy)	Metadata training provided by FGDC staff and a support contractor. A review of metadata collection tools conducted by FGDC for use by implementors. Spring 1997 – Revision of standard to address some user concerns begun. May 1997 – FGDC sponsored working group to provide national input to ISO Metadata Standard begun.

TABLE 4-1 (continued)

A Report Card on Progress

	Actions	Status
Data Standards	Develop thematic data sets that meet critical national needs. (1994)	September 1995 – FGDC Standards Reference Model issued. July 1996 – FGDC invited nonfederal organizations to participate in standards development. December 1996 – Cadastral and wetlands data standards approved by FGDC.
	Promote common classification systems, content standards, data models, and other common models to facilitate data development, sharing and use. (1997 strategy)	January 1997 – 11 different thematic standards in development. July 1997 – Vegetation, soils and SDTS point profile data standards recommended for approval. July 1997 – FGDC standard activities included 4 approved standards; 3 recommended for approval; 15 in development; and 6 proposed for development.
Framework	Through partnerships produce a framework of national digital geospatial data. (1994 Plan)	1994 – FGDC convened an intergovernmental work group to develop framework concept. March 31, 1995 – Framework concept approved. 1995 – Over 20 framework pilots identified. Framework guide for implementors started. 1996 – 7 framework demonstration projects selected by competitive cooperative agreements process.
	Continue to develop the National Geospatial Data Framework. (1997 strategy)	1997 – FGDC and National States Geographic Information Council begin survey of framework data 1997 – Framework guide for implementors complete, final copy ready for printing 1997 - Second round of framework demonstration projects selected
Other	Support the development of tools that allow easy exchange of applications, information and results. Research develop and implement architectures and technologies that enable data sharing. (All from 1997 strategy)	FGDC became member of OGC Management Committee in 1995. 1996-97 OGC developed and is implementing structured process to establish interoperability specifications for geoprocessing. 1997 – OGC & UCGIS representatives attend FGDC Coordination Group Meetings. OGC & UCGIS part of NSDI stakeholder process to define logical and complimentary roles to support the NSDI.

TABLE 4-1: NATIONAL SPATIAL DATA INFRASTRUCTURE IMPLEMENTATION ACTIONS FROM EXECUTIVE ORDER 12906, 1994 FGDC PLAN FOR THE NSDI AND 1997 STRATEGY FOR THE NSDI (continued)

A Report Card on Progress

	Actions	Status
Partnerships	Identify and use various forums for interactions necessary to evolve the NSDI. Identify options for partnerships among all sectors. Develop educational and training programs that ensure availability of trained personnel. (All from 1994 Plan)	1994 – Competitive Cooperative Agreements Program started. In 1994-96 over 65 projects selected. 1994 – FGDC established policy to recognize cooperating groups NSDI presentations given over 250 times across country from 1994-97. 1995 – FGDC becomes member of Open GIS Consortium Management Committee. Mapping Science Committee issues reports on NSDI in 1994 and 1995. Open meetings held at many national conferences by FGDC and cooperating organizations.
	Promote principals and practices of NSDI. Build network of organization linked through common interests for the NSDI. Develop process for stakeholder groups to define logical and complimentary roles to support the NSDI. Find new resources for data production integration and maintenance. Remove regulatory and administrative barriers to agreement formation. (All from 1997 strategy)	1997 – NSDI strategy developed through series of meetings, public review and an open public discussion. Strategy printed in April 1997. July 1997 – 18 state GIS councils recognized as cooperating groups. February 1997 – NSGIC and NACo begin participate on FGDC Coordination Group and Steering Committee. March 1997 – NSDI stakeholders process started to identify logical and complimentary roles - FGDC, NSGIC, NACo, OGC, UCGIS. April 1997 – FGDC Steering Committee meeting including 18 recognized cooperating groups, NACo, NSGIC. 1997 – CCAP program selections completed in July. 1997 – review of previous year CCAP projects conducted - demonstrates that the Program is serving important needs by helping form data partnerships and spreading knowledge of the NSDI.

Source: Federal Geographic Data Committee.

TABLE 4-2: NATIONAL SPATIAL DATA INFRASTRUCTURE IMPLEMENTATION ACTIONS FROM THE NATIONAL PERFORMANCE REVIEW

A Report Card on Progress

Recommendations	Status
Strengthen leadership role of FGDC; Federal agencies instructed to participate fully in FGDC; ▪ FGDC should create and implement common standards. ▪ Adherence to standards should be condition of budgets, including funds allocated to state, local and private sector. ▪ FGDC should participate in OMB-led budget crosscut in 1995.	▪ Executive Order 12906 strengthened FGDC leadership role for federal activities and for coordinating the development of the NSDI. Sec of DOI chairs FGDC with 15 member federal agencies. ▪ FGDC has established a program to create and implement data management, content, and classification standards. ▪ Collection and production of data by federal agencies either directly or indirectly is to be in accordance to standards adopted by the FGDC (EO 12906, Sec. 4 (d)). Budget allocations are not based on adherence to standards. ▪ *Budget crosscut was not conducted in 1995.*
FGDC should establish program by June 1994 for partnerships with goal of 50/50 cost share.	▪ FGDC established partnership programs with state/regional cooperating groups. Cooperative Agreement Program Partnerships have been ongoing with nonfederal organizations since 1994 to provide said money to initiate NSDI activities. ▪ Goals are to share on a partnership basis without a mandatory split.
FGDC should submit schedule and funding plan to OMB by Sept 1994 for collection and production of national core geospatial data by January 2000.	▪ FGDC Framework Working Group developed concept of framework in March 1995. Final document submitted to OMB in June 1995. ▪ *Funding plan not required by EO 12906.*
FGDC should identify thematic data sets of national importance, establish priorities and a funding plan by September 1994 for collection of these data	▪ Critical set of data are being addressed by FGDC subcommittees and Working Groups. Scheduling plan submitted to OMB in October 1994. Work plans have been prepared annually for Subcommittee and Working Group activities. ▪ *Funding plan not required by EO 12906.*
By June 1994, FGDC should create a geospatial data clearinghouse	▪ Clearinghouse established June 1994.
An executive order may be necessary to implement the recommendations	▪ Executive Order 12906 issued on April 11, 1994.

Recommendations not implemented are shown in italics.

Source: Federal Geographic Data Committee.

TABLE 4-3: NATIONAL SPATIAL DATA INFRASTRUCTURE IMPLEMENTATION ACTIONS FROM REPORTS OF THE MAPPING SCIENCE COMMITTEE, NATIONAL RESEARCH COUNCIL

A Report Card on Progress

1993 Report
Toward a Coordinated Spatial Data Infrastructure for the Nation

Recommendations	Status
Strengthen programs of FGDC; Expand and speed development of standards, create incentives for data sharing.	■ EO 12906 strengthened FGDC and Sec. Of DOI. ■ Standards program is in place. ■ Development is time consuming. FGDC continues to refine process. ■ FGDC policies and EO 12906 promote data sharing .
Establish procedures for ready access to information describing geospatial data.	■ Metadata standard endorsed by FGDC on June 8, 1994.
Establish spatial data sharing program. Identify funding and budget crosscuts through OMB and FGDC coordination.	■ Spatial data sharing is an NSDI and FGDC policy. ■ Programs for sharing data exist across government. ■ *Budget crosscuts not identified by OMB. FGDC does not coordinate program funding or budget issues.*

1994 Report
Promoting the NSDI through Partnerships

Recommendations	Status
Clear guidelines for cost sharing in partnership should be developed by FGDC and should reflect federal responsibility to fund nation's interest in NSDI	■ FGDC established partnership programs with State/Regional Cooperating groups. Goals have been to share on a partnership basis without a mandatory split. ■ Data collection is funded by agency programs.
States and other stakeholders should be involved in standards development	■ FGDC invited states and other stakeholders to participate in standards development in July 1996.
Incentives are needed to encourage partnerships	■ Ways of providing incentives through use of data, reduction of costs continue to be explored.
FGDC should investigate extent to which federal procurement rules are impediment to formation of data partnerships	■ The National Performance Review reformed the federal procurement process. ■ *FGDC has not investigated, but impediments may still exist.*

Recommendations not implemented are shown in italics.

Source: Federal Geographic Data Committee.

TABLE 4-3 (continued)

A Report Card on Progress

1995 Report
A Data Foundation for the NSDI

Recommendations	Status
Geodetic control, orthoimagery, and elevation should be the critical foundation of the NSDI.	The framework includes geodetic control, orthoimagery, and elevation as themes.
FGDC should be responsible for development and certification of a foundation and for maintenance and availability.	▪ FGDC is coordinating framework development. ▪ Agencies are responsible for collection and maintenance. ▪ Certification of data is an issue that is not yet resolved.
Specific data themes should be designated as framework.	▪ Seven themes of data designated as framework in report approved March 31, 1995 are: geodetic control, elevation, digital orthoimagery, transportation, hydrography, boundaries, and cadastral.
FGDC should coordinate identification of existing framework data though clearinghouse, encourage integration, and encourage partnership program to populate framework themes.	▪ FGDC has a cooperative agreement with National States Geographic Information Council to conduct a survey of framework holdings. ▪ Clearinghouse and partnerships are key activities in framework.
Additional research and development efforts are needed.	▪ *A research initiative has not been developed. FGDC & UCGIS have begun discussions.* ▪ Several issues (feature maintenance and generalization) are being explored.

Recommendations not implemented are shown in italics.

Source: Federal Geographic Data Committee.

a member of the FGDC by the executive order, but certain of its data and activities can be excluded for reasons of national security. Civilian agencies' autonomy is recognized by the circular, and the FGDC framework omits socioeconomic and other data by current definition (although the framework allows these data to be added as attributes). All departments and agencies – including DOI – are required to contribute to the inventory of spatial data *"to the extent that it is practicable and economical to do so;"* and standards can be promulgated for the recording, storage, transfer, and dissemination of digital spatial data *"to the extent that it is practicable and economical to do so."*[3] [Emphasis added.] E.O. 12906 provides that federal agencies collecting or producing geospatial data are to ensure that the data will be collected in a manner that meets all relevant standards adopted through the FGDC process. However, staff interviews with agency officials revealed that agencies can – and sometimes do – ignore requirements to follow the FGDC standards.

The subject-matter jurisdictions of individual agencies, congressional committees, and OMB resource management offices make crosscutting analyses and action plans difficult to develop and implement. In addition, staff interviews have shown that no one is performing a comprehensive policy or budgetary analysis of GI functions, nor is anyone assessing relationships among basic agency strategies for carrying out their mandates for providing base geographic data to users in and outside of government.

Conclusions

Both FGDC and its efforts to build the NSDI by endorsing standards that are consistent with framework objectives are positive steps in pooling information and achieving better coordination and cooperation within the federal government, among levels of government, and between governments and the private sector. However, FGDC is prevented from having full representation by state and local governments, academia, and the private sector, in part, the staff has been told, because of restrictions in FACA. As long as FACA requirements limit state and local government and private-sector participation, it is unlikely that the FGDC will be fully accepted as a "national committee" legitimately positioned to lead efforts to develop a *national* spatial data infrastructure.

The FGDC does not have adequate staff and funding to achieve federal goals set for the NSDI. It also would benefit by having more staff trained and experienced in policy and management functions at various levels of government.

Recommendations for Immediate Action

- **In order to aid in reconciling conflicts and to monitor agency implementation, designate the OMB program associate director for natural resources, energy, and science to be a full member of the FGDC.**
- **To bring a broader technology perspective to the FGDC, a senior staff member of the Office of Science and Technology Policy also should be a member of the committee.**

Recommendations for Interim Action

- **Further increase state, local, and tribal government participation in the FGDC and encourage stronger involvement by the private sector.**
- **Encourage active participation in FGDC by all agencies having major GI-related programs, including NASA and DoD.**
- **Rapidly grow the current FGDC clearinghouse to (1) identify as much geospatial data as possible, including state, local and private-sector data, and (2) evolve toward user-friendly, on-line data access as technology permits.**

THE NEED FOR A NEW PUBLIC-PRIVATE ORGANIZATION — THE NATIONAL SPATIAL DATA COUNCIL (NSDC)

While the FGDC has been instrumental in much of the progress achieved over the past few years, the Panel is convinced that an organization is needed which provides full participation by all the major parties and interests engaged in developing and maintaining the NSDI. Without such participation, the NSDI is likely to be seen as a federal program run from Washington of limited value to state and local governments. Without stronger private-sector participation, there likely will be less cooperation and continued efforts in Congress to limit or abolish federal capabilities needed to realize the full NSDI. In addition, some of the functions now being performed by government would benefit by the conduct of them in a more businesslike manner.

After considering options in both the public and private sectors, the Panel believes the best of both can be provided by a new nonprofit organization, NSDC, which preferably would be authorized in law by Congress and located within the private sector. This new organization's charter and activities would compliment those of the FGDC, which would concentrate more on coordinating GI functions and activities inside the federal government.

There are at least two precedents for this new organization, one is the National Institute of Building Sciences (NIBS) and the other is ITS America. Both are private nonprofit organizations established by federal law to perform tasks involving all levels of government and the private sector. Not all features of either organization are relevant or applicable to an NSDC, but they provide potential points of departure in fleshing out the NSDC concept. The mission and functions of these two organizations are summarized below.

National Institute for Building Sciences

The National Institute for Building Sciences (NIBS), is a nonprofit, nongovernmental organization that focuses on the resolution of problems that hamper the construction of safe, affordable structures for housing, commerce, and industry throughout the United States.

Charter and Mission

- Chartered by federal law to identify and take actions toward a more rational regulatory environment for the building process
- Provides a forum for bringing together views of all sectors in building-related activities
- Carries out specific functions assigned to it by law and by its voluntary membership
- Facilitates the introduction of new and innovative technology and serves as a nationally recognized source of information on matters of building science, regulation, and technology
- Promulgates national standards
- Provides training and education on the utility of newly developed building techniques

Governance

- Board of directors: 21 members – 6 appointed by the President and confirmed by the Senate. 15 nominated and elected from the nation's building community for a maximum of two three-year terms
- President appointed first board chair, thereafter elected by the board
- Federal employees not allowed to be full board members

- Legislative mandate to: develop, promulgate, and maintain nationally recognized performance criteria, standards, and other technical provisions for maintenance of life, safety, health, and public welfare suitable for adoption by building regulating jurisdictions and agencies. Also mandated to perform evaluations of new technologies, conduct investigations, and serve as a clearinghouse through publications, newsletters, etc.

Functions

- **National Strategy** — through its members, prepares recommendations that are national in scope with broad objectives for the nation's building community
- **Clearinghouse** — publishes the Construction Criteria Base, a quarterly CD-ROM based, two million page, compilation of public and private technical, regulatory and cost information related to various stages of the building process
- **Criteria and Standards** — operates a collaborative criteria and standards-setting process that is technical in nature and national in scope
- **Coordination** — encourages states and jurisdictions to adopt findings and model regulatory provisions into law; provides training for state technical agencies; maintains relationships with the larger information technology community, standards-setting bodies, research organizations, professional associations, and other entities affecting the building industry through interlocking memberships and four affiliated councils under the NIBS umbrella
- **Research and Information** — develops a research agenda that provides objective and timely performance evaluations on the state of progress in developing technologies
- **Product Evaluation** — operates a building and construction product preapproval program to support federal agencies' use of efficient products, materials, and systems

Membership and Financing

- Membership open to all organizations and individuals (approximately 700 members in 1994)
- Different classes of membership (organizational and individual, public sector-private sector, etc.) Sustaining and contributing organizations are charged higher dues
- Received $5 million for fiscal 1975 and $5 million for fiscal year 1976 for start-up activities; thereafter, self-sustaining on grants and contracts ($4.25 million in fiscal 1995), dues, and publication sales

ITS America

ITS America (formerly IVHS AMERICA) is a national public/private organization established to coordinate the development and deployment of intelligent transportation systems in the United States.

Charter and Mission

- Goal – deployment of basic ITS services for consumers of passenger and freight transportation nationwide by 2005

- Mandated by federal law to foster public/private partnerships that will increase the safety and efficiency of surface transportation through the accelerated development and deployment of advanced transportation systems
- Provides a forum through which organizations can meet, evaluate teaming partners, find technology solutions, and announce their capabilities to the global ITS community
- Fosters international cooperation in research, development, and deployment of ITS
- Facilitates the introduction of new and innovative technology, and disseminates nationally recognized technical information

Governance

- Board of directors - 49 members elected from membership.

Functions

- **National Strategy** — ITS America National/State Chapters Partnership Program designed for local deployment of a smoothly integrated national ITS program
- **Clearinghouse** — National ITS Clearinghouse provides members with online access to information, complete with RFP listings and other opportunities available through federal, state, and local government agencies
- **Standards** — oversight on numerous standards-setting activities that are technical in nature, focusing on issues of interoperability
- **Coordination** — state chapters voice in the continuing development of the national ITS program and planning process. The chapter program's purpose is to form state-level public/private/academic partnerships designed to foster deployment of ITS technologies. Through the program, ITS America is establishing a network of state-based ITS organizations to create these local partnerships. ITS America state chapters encourage information exchange, develop grassroots participation, create local public-private forums, and serve as a deployment resource.
- **Research and Information** — as a utilized federal advisory committee to DOT, ITSA members help to set national program strategies and play a primary role in defining strategies for the deployment of ITS technology.

Membership and Financing

- Membership is comprised of federal, state, local, and foreign government agencies; national and international corporations involved in the development of intelligent transportation systems (ITS); universities, independent research organizations, public interest groups, and other organizations with an abiding interest in solving the nation's transportation problems through the use of ITS technology (over 1,000 participating organizations: 50 percent private sector, 50 percent public, consumer, and academic organizations).
- Dues are based on gross annual revenues (or, in the case of private trade associations, budget base). Start-up moneys derived from dues and a congressionally directed DOT contract.

Organizational Framework of the NSDC

The new organization would have the following characteristics:

Charter and Mission

Established preferably by a new federal law, the basic mission of the NSDC would be to advance national goals set for the NSDI. The council also would:

- provide a forum for bringing together the views of all sectors engaged in developing, maintaining, and using the NSDI
- serve as a link with other public and private-sector organizations engaged in GI-related activities, the NII, and policy communities using GI
- carry out specific functions assigned to it by law or by its membership

The Council

The initial council, or board of directors, could be appointed by the President for fixed terms not to exceed three years. Members could be nominated by governmental and private-sector organizations and academia with the goal that all sectors are to be fairly represented.

The council would set internal policy and oversee NSDC operations and provide advice to the secretary of interior (FGDC chair) on GI issues involving the federal government. It would elect its own chair and set the ground rules for its operation.

Subsequent councils would be elected by the organization's membership, provided that all sectors would continue to be represented.

Goals and Objectives

The Panel suggests the following broad goals and objectives for the NSDC:

- provide a national forum for developing and maintaining the NSDI
- maintain state-of -the art knowledge about advances in GI and related technologies.
- help ensure that goals set for the NSDI are actually carried out in practice by serving as a catalyst for implementation
- build a comprehensive and user-friendly GI clearinghouse using a customer-responsive and businesslike approach
- bring the views of all interested parties to the table on national standards and possibly over time assume the responsibility for this function now housed in the FGDC
- provide training and education on the utility of and techniques fostering the NSDI

Functions

The NSDC would perform several functions to advance the NSDI, as follows:

- **National Strategy** – In cooperation with the FGDC, its own membership, and others, prepare a national strategy document outlining responsibilities and broad goals and objectives for all sectors so as to build an integrated system

- **Clearinghouse** – Operate a user-friendly clearinghouse available to all organizations that provide access to public, as well as privately generated GI. Basic governmental data provided would be available at no cost or for the cost of reproduction and distribution, but private and some state and local government data and value-added services could be provided on a fee basis
- **Standards** – Coordinate standards-setting for all GI standards applying to sectors beyond the federal government
- **Coordination** – Maintain relationships with the larger information technology community, standards-setting bodies, research organizations, professional associations, and other entities affecting the NSDI.
- **Capacity building** – Foster actions and investments to build the GI capacities of state, local, and tribal governments not now able to contribute to or use the NSDI effectively
- **Research and Information** – Help develop a GI research agenda for all sectors and provide a user-friendly information source on research results and for work in progress. It also could provide objective and timely performance evaluations on the state of progress in developing the NSDI and the spatial data community, generally

Membership and Financing

Membership would be open to all organizations and individuals willing to pay membership dues. Such dues could vary in amount, depending on the size of the organization and level of involvement with GI. Different classes of membership (organizational and individual, public sector-private sector, etc.). Sustaining and contributing organizations would be charged higher dues to help finance the NSDC.

Legislation establishing the NSDC could provide for an initial three-year federal grant for start-up activities. Fees would be charged for value-added services.

Headquarters and Regional Operations

The NSDC's main offices logically would be located in the Washington, DC area so as to coordinate with the FGDC, federal agencies, organizations representing state and local governments and the commercial sector, and with Congress. However, given the increased interest in regional or placed-based operations for many federal and other programs, other offices could be established throughout the country, preferably near field offices of the Geographic Data Service (GDS) recommended in Chapter Five.

Regional councils could oversee operations covering their local areas, similar to NOAA's practice for fisheries management under the Magnuson/Stevens Fisheries and Conservation Management Act which provides for regional councils.

Relationship to Existing Organizations

Some of the missions and functions outlined above are being performed now. In some cases, the NSDC would assume these responsibilities as designated in its statutory charter. For example, the NSDC would broaden the clearinghouse function now being performed by the FGDC and might eventually take that function over. In other cases, the NSDC would compliment existing activities. For example, the research and information functions of the NSDC would compliment and build on activities of the UCGIS, professional societies, universities, and the federal government.

Existing organizations, such as the OGC, now have related activities under way or planned. OCG, for example, was established to develop interoperable geo-processing technology specifications, but it has broadened its mission to include, among other objectives, service as an industry forum that "promotes cooperative business development initiatives related to distributed geo-processing." This membership organization appears to be making useful contributions to the development of open GIS software, and it would be helpful for it to have a productive and complimentary relationship with the NSDC. To an extent, OGC and the new organization's membership would overlap as would some of their functions. Because any private-sector organization's ability to influence the course of events in government is limited, it is important that organizations like these work together to promote common interests.

A side-by-side comparison of the functions to be performed by the NSDC and the FGDC, following establishment of the former, is shown in Table 4-4.

Conclusions

Some promising first steps have been taken in the three years since E.O. 12906 was issued, but the NSDI concept appears to not yet have been widely adopted within the federal government, and it is even less well-known at the state and local levels and in the private sector. State officials have informed the staff of the necessity to educate federal field offices about the NSDI.

Although Circular A-16 and E.O. 12906 provide a soundly conceived policy base for the FGDC, a statutory mandate for a new, public-private NSDC that provides for full participation by state, local and tribal governments; greater involvement by the private sector; and exemption from FACA would significantly improve the pace for fulfilling the vision set for the NSDI.

Recommendations for a Long-term Solution

- **Increase congressional, state legislature, county commission, city council, professional association, commercial, and public awareness of the NSDI's current and potential value, and current plans and strategies to develop it.**
- **Establish through legislation a national goal to create and maintain a robust NSDI.**
- **Create a private, nonprofit NSDC, modeled on the current FGDC and NSDI charters, with appropriate representation by all levels of government and the private sector.**
- **Retain FGDC, with ties to the NSDC, to coordinate federal GI under the NSDI.**

In policy comments on a draft of this report, the sponsoring agencies differed on the merits of creating an NSDI. USGS said "the chapter provides positive support for a truly national NSDI effort. USGS supports the general concepts of strengthening the . . . FGDC and of creating a national coordinating body to allow for equal representation of all components of the NSDI." On the other hand, NOS said many questions about this

TABLE 4-4: COMPARISON OF FUNCTIONS PERFORMED BY NATIONAL SPATIAL DATA COUNCIL AND FEDERAL GEOGRAPHIC DATA COMMITTEE

	NSDC	FGDC
Membership	Broad and open membership.	Strengthen agency participation; expand federal agency members.
NSDI Strategy	Prepare a national strategy document outlining responsibilities and broad goals and objectives for all sectors.	Prepare and monitor implementation of an NSDI strategy for the federal government.
Standards	Coordinate for all GI standards applying to sectors beyond the federal government.	Develop standards applicable only to federal government; provide input to NSDC on other standards.
Framework	Provide state/local/private-sector input to federal government on framework development.	Coordinate federal framework activities in cooperation with Geographic Data Service.
Clearinghouse	Operate a user-friendly clearinghouse, available to all, that provides access to public as well as privately generated GI.	GDS would operate or coordinate federal clearinghouse nodes.
Partnerships	Encourage and provide technical support for multi-lateral partnerships.	Encourage partnership development and expansion among federal agencies.
Metadata	Encourage metadata creation in state and local governments and private sector.	Encourage metadata standards implementation across federal government.
Grant Programs	Encourage and coordinate grants to improve local GI capacity.	Continue operating CCAP and other grant programs and support pilot projects.
Conferences	Hold annual conference to review progress in creating the NSDI. Could be supplemented by regional conferences to help tailor NSDI development in given geographic areas.	Continue periodic meetings of the FGDC Steering Committee, Coordinating Committee, Standards Working Group, etc.
Research and Information	Help develop a GI research agenda for all sectors and provide a user-friendly information source on research results and work in progress.	Coordinate GI research agenda for the federal government and federally-supported research.
Committees	Establish committee structure to address major challenges.	Continue existing committee structure for federal functions.

new organization "are left unanswered," and it expressed concern that the proposed financing/membership arrangement for the NSDC "will favor large, private sector interests and will stifle the development of innovative, smaller private GI firms." NOS said efforts to strengthen FGDC would be a "logical and reasonable first step" and offered several specific suggestions on how FGDC could be strengthened (see Appendix J).

USGS also said: "The background given on FGDC in this section understates the institutional barriers in Federal agencies, where the trickle-down of policy and standards from the steering and coordination committees is often dysfunctional." It wondered why the Panel did not recommend either relaxation of FACA restrictions on FGDC or provide other options, noting that: "Recommendations to the FGDC to more actively involve nonfederal entities certainly cannot be implemented without such action."

The Panel has recommended that NSDC be established and FGDC be continued as a federal committee. If this is the course taken, then it would not be necessary to alter FACA's applicability to the FGDC. With federal members only, no exemption would be needed. If the choice is to strengthen FGDC as NOS suggests, then exemption from FACA would be a logical step to facilitate state, local government, and private-sector participation.

USING THE RESULTS ACT (GPRA) AS A TOOL FOR COORDINATION

The Results Act (short for the Government Performance and Results Act – Public Law 103-62 – or GPRA) has stimulated federal agencies, including those engaged in GI, to take a more strategic approach to planning and performance measurement for their programs; however, no one is doing any crosscutting analyses of whether the GI goals and strategies being developed under GPRA are consistent and complimentary.

GPRA requires federal agencies to set goals, measure performance, and report annually on the degree to which goals are met. Congress anticipated that agencies would need to make significant management changes to meet the act's requirements, so its provisions were phased in over several years. In fiscal year 1997, agencies have concentrated on preparing strategic plans for initial publication on October 1 after review by OMB and consultation with Congress. The Act's major provisions are summarized in below.

Results Act (GPRA) Requirements

- **Strategic Planning.** Each federal agency must submit a strategic plan covering a period of five years that includes: (1) a comprehensive mission statement covering the major functions and operations of the agency; (2) general goals and objectives, including outcome-related goals and objectives, for these functions; (3) a description of how the goals and objectives are to be achieved, including the operational processes, skills, and technology, and the human, capital, information, and other resources required; (4) a description of how the general performance goals are related to specific operational goals and objectives; (5) identification of key factors external to the agency and beyond its control that could significantly affect the achievement of the general goals and objectives; and (6) a description of the program evaluations used in establishing or revising general goals and objectives, with a schedule for future evaluations.

- **Annual Planning.** Each agency must prepare an annual plan covering each program activity in its budget. The plan: (1) establishes the level of performance to be achieved by a program activity; (2) expresses performance goals in an objective, quantifiable, and measurable form; (3) describes the operational processes, skills and technology, and the human, capital, information, or other resources required to meet performance goals; (4) establishes performance indicators to be used in measuring or assessing the relevant outputs, service levels, and outcomes of each program activity; (5) provides a basis for comparing actual program results with the performance goals; and (6) describes the means used to verify and validate measured values.
- **Annual Reporting.** The act also requires that each agency head submit an annual report to the president and Congress to provide a thorough review of performance for the previous fiscal year. Each report must: (1) review the success of achieving performance goals for the fiscal year; (2) evaluate the performance plan for the current fiscal year relative to the performance achieved toward the goals in the prior fiscal year; and (3) where a performance goal has not been met why the goal was not met and, if so, what is being done to manage the situation.

Agency Responses to the Results Act

All agencies sponsoring this study have drafted strategic plans as required of federal departments and major agencies by the act. However, these plans, like those for other federal agencies, address primarily their own programs without extensive consultation with agencies performing similar functions. This is consistent with the findings of GAO on GPRA implementation outlined in a June 1997 report. Regarding the challenge federal crosscutting programs pose for implementing GPRA, GAO said:

> Uncoordinated program efforts can waste scarce funds, confuse and frustrate program customers, and limit the overall effectiveness of the federal effort. A focus on results, as envisioned by the Results Act, implies that federal programs contributing to the same or similar results should be closely coordinated to ensure that goals are consistent, and, as appropriate, program efforts are mutually reinforcing. This means that federal agencies are to look beyond their organizational boundaries and coordinate with other agencies to ensure that their efforts are aligned.

Earlier GAO work in many program areas suggested that significant overlap and fragmentation existed in the federal response to national needs and problems, including federal land management. While some crosscutting efforts have been undertaken in areas such as federal credit policy and the national drug control strategy, OMB concluded in 1996 that, on the whole, there was little sign of significant coordination among agencies. When project staff contacted OMB about crosscutting initiatives under GPRA, they were advised that their staff were focusing on getting out the required strategic plans and not on crosscutting analyses.

The Panel believes that NSDI implementation would benefit by having crosscutting analyses performed for GI programs and activities. FGDC has published an NSDI strategy document that has no direct relationship to agency strategic plans and relies on its own process of consulting with specific agencies on plan implementation. FGDC staff reported good cooperation in meetings with agency officials, but the one implementation plan provided to the Academy had only a sketchy outline of actions to be taken and their few associated milestones or resource requirements.

A cross-cutting analysis is unlikely to capture all significant GI-related issues. USGS staff have pointed out that GI and GIS are "tools" to facilitate program implementation which are unlikely to be addressed separately in agency performance plans. Nevertheless, GI activities are specifically mentioned in many agency plans (NMD has its own plan which is a subset of the USGS plan), and comparisons could be helpful in identifying areas where better coordination could be beneficial.

Agencies are required to submit their first annual performance plans with the President's fiscal year 1999 budget in early 1998. This provides an opportunity for additional coordination across agencies on NSDI strategy implementation. FGDC, working with cognizant OMB staff, could take the lead in ensuring that such coordination occurs.

NIMA's Global Information Infrastructure (GII) Master Plan As a Possible Model for the NSDI

In the long run, the Panel believes a broader and stronger strategy is needed than now exists – or even what might be gained through crosscutting analyses of Results Act plans – to ensure full development of the NSDI. The broad strategy facilitated by the FGDC, which relies on the voluntary implementation actions of all major federal agencies engaged in GI is not sufficient, in the Panel's judgment, to provide the foundation for the coordinated efforts required for the NSDI.

One potential model for a stronger strategy is the master plan for the GII developed by NIMA's Integrated Product Team. Although the plan had not been formally adopted as this was written, nor had it been implemented, the plan's structure and content, as well as the process for developing it, could provide a template for a comprehensive NSDI plan. (The Panel is not talking here about the substance of the plan –there are significant differences between actions needed to meet national defense needs for GI and those required for the civil community.)

The GII master plan includes the following essential components:

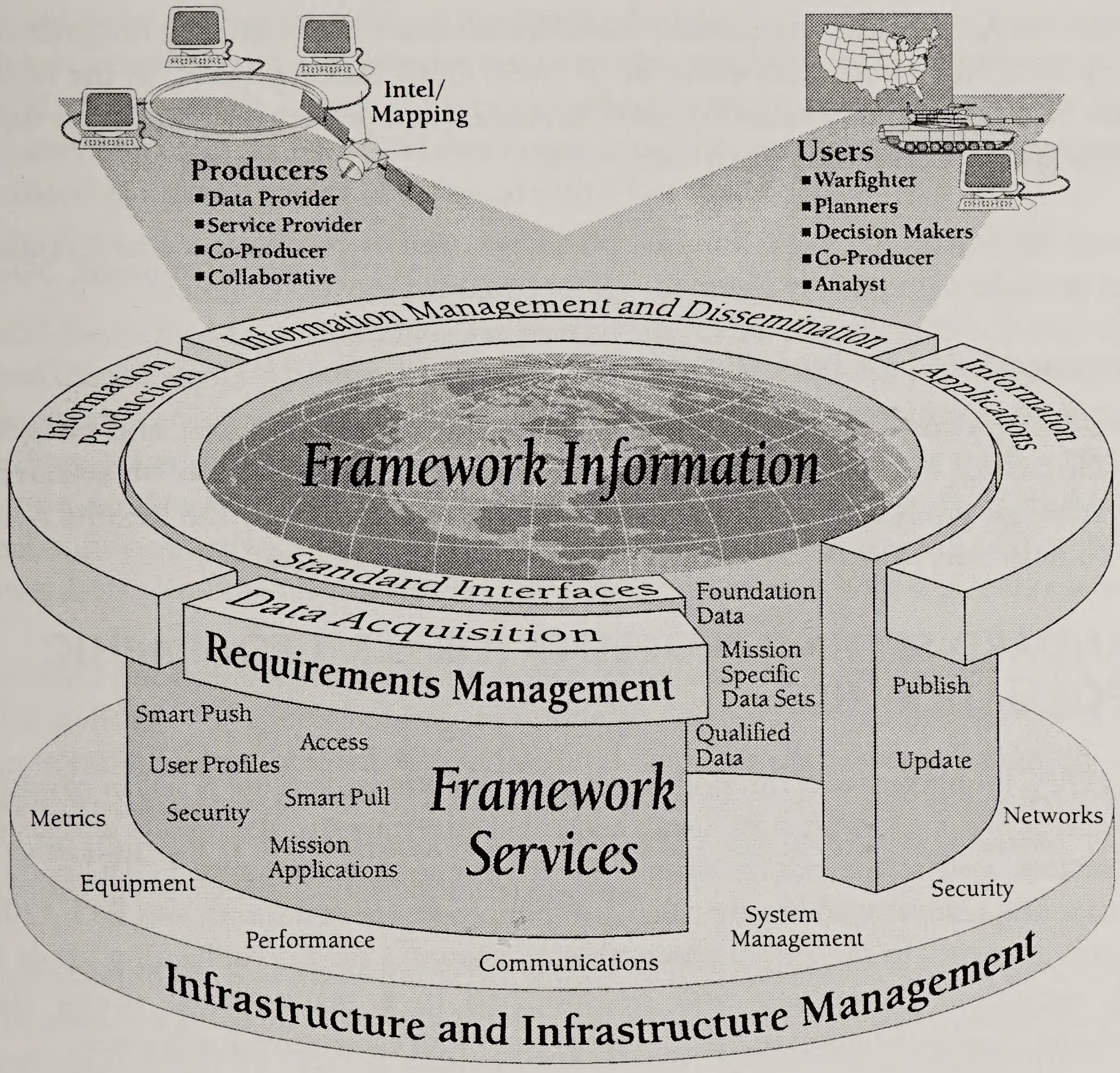
- a description of the requirements to be met
- a vision tied to the mission
- a framework and its components
- the operational, technical, and support architectures
- relationships to the overall information support strategy for the defense community.

Figure 4-1 provides an excerpt from the plan describing the GII vision.

Various documents prepared for the NSDI contain all of these components in some form, but individually and collectively, they do not provide a blueprint to guide the actions of all the parties involved in developing the NSDI. The actions being taken by federal agencies engaged in GI have been guided more by program missions and organizational imperatives than any coherent strategy. Developing and actually implementing such a strategy is an enormous challenge under the best of circumstances. Planning for a GII, complex as

FIGURE 4-1: THE VISION FOR DoD'S GLOBAL INFORMATION INFRASTRUCTURE (GII)

The GII is proposed as a new enabling infrastructure to meet the needs of the community for geospatial information. The infrastructure is the collection of people, doctrine, policies, architectures, standards, and technologies necessary to create, maintain, and utilize a shared geospatial Framework.



The GII will provide geospatial information, products and services within an increasingly austere, yet dynamic and demanding national security environment. As depicted above, the vision is based on concepts which will increase the efficiency and effectiveness of the components of the infrastructure. The GII:

- Establishes a Framework for acquiring, producing, managing, and disseminating geospatial information;
- Provides the supporting services needed to ensure information content meets user mission needs, is easily accessible, and can readily be applied to support mission information requirements;
- Ensures the supporting infrastructure components (including doctrine, policy, training and force structure) are in place to optimize the use of the geospatial information, products and services provided.

Source: Department of Defense Integrated Product Team, Geospatial Information Infrastructure Master Plan, Volume 1, Overview, Version 1.0, draft, 2 October 1997.

that may be, is not as challenging as building an NSDI for the diffuse civil sector because the whole GII system is designed to meet the needs of a single customer (the military war fighter who needs to know where he or she is on the field of battle). In contrast, GI is used in the civil sector to meet an almost infinite variety of needs. Without such planning, however, the data sets available from the NSDI are likely to be more a collection of what is otherwise available versus what could be provided following a more coherent strategy.

Conclusion

The Results Act provides a potentially useful framework for coordinating the goals and strategies of federal agencies active in GI. With OMB backing, FGDC is the logical forum for developing coordinated goals, strategies, and performance measures using the Results Act requirements as a framework.

Beyond the Results Act, the GII master plan developed by NIMA's Integrated Product Team provides a potentially useful model for NSDI strategy development.

Recommendation for Immediate Action

- **Develop coordinated goals, strategies, performance measures, and budgets for federal agency GI programs and activities. Explicitly establish selected strategic goals and performance measures, as required by the Results Act, to help move the NSDI toward further and faster realization.**

STANDARD-SETTING PROCESSES FOR U.S. GEOGRAPHIC INFORMATION (GI)

The FGDC is charged with developing standards to implement the NSDI in consultation and cooperation with state, local, and tribal governments, the private and academic sectors, and, to the extent feasible, the international community. FGDC and the participating federal agencies are called on to promote the standards, and E.O. 12906 requires agencies, to the extent practicable, to ensure – prior to obligating funds for such activities – that data will be collected in a manner that meets such standards.[4]Implementation of the standards rests with each individual agency.

This is a difficult and complex federal mandate. Circular A-16 gives the FGDC responsibility for coordinating federal surveying, mapping, and related spatial data activities. The goals were to develop a national spatial data information resource, reduce duplication, reduce the expense of data collection, and increase data sharing. This is to be accomplished, in part, by "promoting the development, maintenance, and management of distributed database systems that are national in scope for surveying, mapping, and related spatial data."[5]

Development of federal content standards with the emergent IT technologies, interoperability, and established GI standards remains central to NSDI goals and objectives. The federal government is currently the national leader in and serves as an international model for GI standard setting. The FGDC coordinates standard setting that is intended to be national in scope – going beyond individual federal agencies to develop a common reference for data collection and transmission in support of national and collective decisionmaking with GI applications.

In addition to federal efforts at GI standard-setting, state and local governments, the private sector, professional societies, academia, and other individuals are active in supplemental and alternative standard-setting practices. All parties recognize the current and potential economic benefits attached to GI standards. Economic rationality, in fact, largely drives standards promotion, adoption, and implementation.

Current implementation strategies for compliance with FGDC standards are largely undeveloped, and they vary from agency to agency. Federal agencies, in fact, often collect and maintain data according to their particular agency standard and data model, or a project-specific standard. Agencies need to encourage diffusion of information about FGDC and standards in order to get field offices to implement standards. The focus and attention of increased FGDC awareness should be centered on how to implement decisions in the field and on the ground with other stakeholders.

FGDC Standard-setting Process

FGDC has formed 12 subcommittees of its members to develop standards. It also established the Standards Working Group (SWG) to provide guidance to the subcommittees on standards policies and procedures, and to review standards proposals and standards documents for compliance with these policies and procedures. The SWG also may sponsor the development of standards that crosscut the subcommittees. The SWG recommends standards for final endorsement to the FGDC Coordination Group, which forwards its recommendations to the FGDC Steering Committee for final endorsement.

The SWG published a Standards Reference Model in March 1996 to document standards policies and procedures and to provide guidelines by which the FGDC will conduct standards development. The procedural steps for developing a standard were based on the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO) processes. Standards maintenance is not included in the standards development process.

In addition to the Standards Reference Model, FGDC has enumerated several criteria to be used as a guide for developing FGDC standards, including expectations that standards should remove existing impediments to sharing information and promote new arrangements to make the data easily accessible for public consumption, and that standards that emerge will be widely known and supported by private-sector GI interests.

FGDC Standards Strategy and Activities

As this was written, there were four FGDC endorsed standards: the Content Standard for Geospatial Metadata, the Spatial Data Transfer Standard (SDTS), the Cadastral Data Content Standard, the Classification of Wetlands and Deep Water Habitats, the Soil Geographic Data Standard, and the National Vegetation Classification Standard. The Metadata and SDTS standards continued to undergo revision in an effort to stay current with evolving demands and needs being placed on these two standards.

Standards are sponsored and impelled by the agency designated by A-16 and the FGDC as responsible for that particular theme. The SWG has a large number of standards to be processed – as of September, 1997, 22 proposed standards were in various stages of SWG review (see the listing on the following page). This is because SWG members work on a voluntary basis and are able to process an average of two standards each month. The SWG has also developed a work plan, including goals, objectives, and actions. It also is developing a detailed strategy for each goal. A complete timetable for goal completion is not available.

Status of FGDC Standards

The following list represents the 22 FGDC standards in different phases of standard development.

FGDC-Endorsed Standards

- SDTS Parts 1–4 (FIPS PUB 173, 1992)
- Geospatial Metadata, version 1.0 (June 1994)
- Cadastral (December 1996)
- Wetlands (December 1996)
- Vegetation Classification (October 1997)
- Soils Data (October 1997)
- SDTS, Part 6: Point Profile

Upcoming Public Reviews

- Utilities Data
- Facility ID
- Metadata Encoding
- Geospatial Positioning Accuracy, Part 4
- SDTS, Part 5: Raster Profile
- The CADD Profile for SDTS

Standards in Draft

- Metadata Profiles
  - Cultural and Demographic Data
  - Biological Resources Data
- Address
- Environmental Hazards
- Geologic Data Model
- Geologic Mapping
- Remote-sensing Swath Data
- National Shoreline Data
- Geospatial Positioning Accuracy, Part 5
- Earth Cover Classification

The SWG is currently focused on revising the U.S. metadata standard to require a set of "core" data and to allow supplemental metadata to accompany the file. The SWG policy is to formally adopt the revised metadata standard and, in keeping with OMB Circular

A-119, promote the U.S. metadata standard internationally. It is important to note that use of software embedded requirements often become de facto standards. The latest version of ARCINFO has fields for recording metadata that are not consistent with the FGDC standard. USGS advises that discussions are taking place with ESRI related to this potentiality.

The FGDC data transfer standard, SDTS, also has a long history of development, and continues to undergo enhancement. Even though SDTS is a Federal Information Processing Standard (FIPS), a widely used data exchange mechanism for the federal government does not exist. This is largely a testament to the abilities of private companies that have recognized and satisfied the emerging needs for sharing data between platforms and applications. At the same time, because of commercial proprietary reasons and agency dominion over their corporate databases, there is not widespread demand for sharing data among disparate platforms. Opinions vary on the future utility of adding additional "profiles" to SDTS. The capability to communicate among various vendors' systems and provide an interoperability, once only possible through the use of sophisticated and costly data transfers, progresses apace, calling into question the extended efforts and utility in evolving SDTS.

Agreement on the meaning of the exchanged information is key to an NSDI. For these reasons, private sector providers of GI and the Open GIS Consortium (OGC) fully support the identification of data content standards. Current efforts of many OGC members focus on developing interfaces that allow translation of spatial data from one proprietary format to a standard or "neutral" format, from which the information can again be translated into a second proprietary format. Public law requirements to provide data in non-proprietary formats illustrates the differences between the public and private sectors in this area.

State and Local Standards Initiatives

Participation in the FGDC standards-development process in an advisory capacity to the standards working group subcommittees is open to state and local governments. Their involvement historically has been minimal or non-existent. Resultant standards, therefore, have not usually reflected state and local perspectives or needs.

State and local governments, for instance, have criticized FGDC's cadastral content standard for its complexity and for serving primarily federal objectives. State and local GI professionals lack incentive to participate in standards development or adhere to FGDC standards. In the absence of federal implementation strategies and incentives, state and local governments develop their own methods to meet their GI needs.

Greater nonfederal input into standard development needs to occur before the standards can be viewed as national in scope. This may necessitate the development of criteria that must be satisfied before FGDC endorses a standard. For example, a designated group of state, local, and private-sector representatives could be consulted before a standard moves forward for adoption. NSGIC, NACo, and OGC should be involved in establishing this process. In addition, the NSDC, recommended earlier in this chapter, should provide a forum for state and local government and private-sector input.

Some federal departments, such as USDA and DOI, are more engaged with state governments in efforts to promote FGDC standards. Continued state and local government participation in standard-setting was underscored by the MSC when they stated that it is "imperative that states and other organizations be involved in the standards development process and that only standards essential to NSDI objectives be required of partnership agreements," adding: "Standards must not be compromised in the formation of partnerships."[6] However, there is no agreement in the national GI community as to which standards are essential and realistic, or how to measure success in implementation.

Relationship of Federal Standards to the Framework and NSDI

The FGDC has given priority to framework activities which generate guidelines for developing standards as they apply to framework data themes. Vector Framework data layers are being developed according to a feature-based data model, including feature identification codes. The "feature," a description of a geographic phenomenon, is assigned a permanent feature identification code. Additional attributes and relationships can be attached to the feature.

Conformance to FGDC standards is a minimum requirement to participate in framework development. In the process of developing data for framework, additional needs for GI standard-setting emerge. Several of the standards currently in the SWG process are those identified by framework activities, but they do not necessarily receive priority attention. A formal mechanism or structure is not in place that provides for transmission of standards identified as a result of framework activities into the FGDC standard-setting process. This is essential to assure a properly integrated suite of FGDC standards.

The Role of the Private Sector in National Standard-setting for GI

One common vision of the NSDI requires a distributed database management system (DBMS). A distributed DBMS can be thought of as multiple geographically distributed databases managed as a single, integrated database. Interoperability generally refers to a bottom-up integration of pre-existing systems and applications that were not originally intended to be integrated.

Private sector efforts have focused largely on Application Processing Interface (API) standards, that is, the interface between the application software and the application platform, across which services are provided. APIs are systematically combined to address problems that require interoperation of multiple DBMS and application programs. Since different organizations develop systems and applications to address their specific sets of problems, interoperability becomes central to a workable NSDI. SDTS resolves some of the obstacles posed by transferring data between platforms, and the additions of profiles to the transfer standard makes it more robust so that it can better accommodate disparate data sets between platforms. Until the private sector solves the direct transfer of data between platforms, SDTS will be looked to as the common denominator to exchange data. Even so, the issue of standards that speak to data model or semantic representation of GI are not solved by interoperability. If SDTS is to be a truly workable standard, the private sector must be persuaded to commit resources to the creation of workable SDTS linkages.

Other Leading Players in Standards Development

FGDC is joined by numerous organizations, nationally and internationally, in developing and supporting standards relevant to the NSDI. These various standards development activities often impact one another.

UCGIS provides a unique institutional infrastructure which brings together specialists from the various disciplines (both technical and cognitive) required to successfully accomplish interoperability. UCGIS convenes experts from government, industry, and academia and researches solutions for both short-term, domain-specific issues, as well as for longer-term interdomain problems.

The Information Infrastructure Standards Panel (IISP) promotes and coordinates the development of standards needed to support the National Information Infrastructure (NII) and the GII. IISP does not set standards. Instead, the focus of the IISP is on identifying needs for standards and then raising awareness of the need with the appropriate standard-setting body.

IISP has an applications area working group that focuses on specific NII components. GIS was added recently as a necessary focus area and FGDC was asked to join the initial panel. This mechanism gives FGDC an avenue into influencing NII and GII standards and their potential coordination with NSDI standards. FGDC and the participating federal agencies can only encourage nonfederal and private-sector organizations to use its standards.

ANSI is a private, nonprofit membership organization supported by private and public sector organizations. It facilitates development of American National Standards (ANS) by establishing consensus among qualified groups. ANSI accredits organizations, commissions, and others to develop ANSs and ensures that each of these entities adheres to guiding principles such as consensus, due process, and openness. ANSI currently represents the interests of approximately 1,700 U.S. companies, organizations, government agencies, and institutional and international members. State and local governments, however, do not have a visible presence in ANSI.

In 1993, ANSI established a subcommittee to deal with GI-related standardization. It is now referred to as the National Committee for Information Technology Standards (NCITS). ANSI promotes the use of U.S. GI standards internationally, advocates U.S. policy and technical positions in international and regional standards organizations, and encourages the adoption of U.S. national GI standards as international standards where these meet the needs of the user community. ANSI is the sole U.S. representative and dues-paying member to the ISO.

ISO is a worldwide federation of national standards bodies from about 100 countries. Its mission is to promote the development of standardization and related activities throughout the world to facilitate the international exchange of goods and services, and to develop cooperation in the spheres of intellectual, scientific, technological, and economic activity.

Through ANSI, the United States has immediate access to the ISO standards-development processes. ANSI is a founding member of the ISO and plays an active role in its governance. ANSI is one of five permanent members of the governing ISO council, and one of four permanent members of ISO's technical management board. As part of its responsibilities as the U.S. member to the ISO, ANSI accredits each Technical Advisory Group (TAG). The TAG's primary purpose is to develop and transmit, via ANSI, U.S. positions on activities and cast ballots at the international technical committee meetings.

To date, ISO's work has resulted in 9,300 international standards. None are directly related to geographic information. In April 1994, however, ISO established a technical committee (ISO/TC 211, Geographic Information/Geomatics) to serve the international community of users of GI standards. The committee is considering the adoption of a metadata standard.

The International Hydrographic Organization (IHO) has 62 maritime nations as members. About 10 more states are in the process of becoming members. The IHO has consistently worked towards achieving maximum standardization in the specifications, symbols, style, and formats used for nautical charts and related publications so that today, the mariners of the world are able to use with confidence charts compiled by any member of the organization. IHO is looked to for international nautical charting standards.

The IHO has an important relationship to the FGDC because the IHO established two standards that the bathymetric subcommittee of the FGDC is considering. These two standards are S-44, Standards for Hydrographic Surveys, and S-57, Transfer Standards for Digital Hydrographic Data (DX-90), Edition 3.0. IHO standard S-57 illustrates the challenges U.S. representatives face from the public and private sectors in the international community. NATO and numerous countries use a different vector format (VPF) for nautical charting while IHO has endorsed S-57, which is an alternative vector format.

Numerous international organizations concentrate on particular components of GI. The International Federation of Surveyors (FIG), for example, was established to ensure that all who practice the discipline of surveying meet the markets and communities that they serve. FIG would consider a content standard for cadastral. The International Cartographic Association (ICA), and International Society for Photogrammetry and Remote Sensing (ISPRS) are among the larger and more prominent international professional organizations. They all emphasize different aspects of the profession, but all have subcommittees doing scientific and/or professional work and studies, often focusing on standardization.

In Europe, individual national GI standards organizations are increasingly giving way to the three major European standards-setting organizations: ISO, IHO and CEN, which is the European committee for standardization. CEN produces European standards in all areas except for electrotechnical and telecommunications. ANSI is actively trying to participate in the standards activities of the European standards organizations. If successful, U.S. firms will be able to access the European standard's deliberations through ANSI.

FGDC might not itself have the resources for coordinating the U.S. position, but working groups under the FGDC Coordination Group are, in fact, able to coordinate the U.S. position on international standards and to leverage resources across the country to effectively present positions in ANSI and ISO. An example is the Metadata Working Group, which is developing the U.S. position on the emerging ISO metadata standard.

Conclusions

The Panel concludes that:

- FGDC's GI standard-setting mandate is extremely difficult to accomplish. There needs to be a wide range of substantive input during development of GI content standards in order for them to be considered national in scope. USGS advises that FGDC is moving in this direction. Standards-setting would benefit by creating a NSDC or other public-private organization with representation of all parties affected by the standards.
- Standards being developed in the context of the seven framework layers and the 12 FGDC subcommittees appear to provide a useful strategy to guide federal data collection activities.
- Better coordination of standards needs, identified through framework activities, is essential to assure a properly integrated suite of FGDC standards.
- FGDC lacks the structural and institutional strength to meet alone the emerging domestic and international standard-setting challenges.
- Federal agencies need to encourage diffusion of information about FGDC and standards and develop implementation and enforcement strategies, as well as compliance and performance measures, for their own respective agencies.
- It is in the national interest to carefully monitor and influence the progression of FGDC standards through ANSI and ISO. Coordinated leadership that is national in scope is necessary to adequately represent the U.S. position to ANSI.
- The existence of military and civilian standards for GI will be a likely source of debate among international standards bodies for GI. The United States will be faced with standards that have their genesis in NIMA/NATO standards.

Recommendations for Immediate Action

- **Concentrate FGDC standard-setting activities on data content standards for the framework layers.**
- **Increase staff support for FGDC secretariat functions and dedicate staff in each agency for standards development, implementation, compliance, and outreach, especially to federal field offices.**
- **Develop performance measures for agency development and compliance with FGDC standards.**
- **Improve structural coordination of framework activities and the FGDC standard-setting process.**
- **Make use of ongoing initiatives, such as land-use planning for public lands and ecosystem management, as drivers to strengthen state/local support for common standards.**
- **Establish a FGDC presence on the IISP.**
- **Provide for stronger FGDC-NIMA coordination on international standards.**

Recommendation for the Longer Term

- **Standards that are national in scope should be coordinated by the NSDC. FGDC would represent the federal viewpoint in this council.**

STATE AND LOCAL GOVERNMENT COORDINATION INITIATIVES

Each of the 50 states and virtually all urban areas of the United States have undertaken efforts to improve GI leadership and coordination, increasingly with federal field offices. Similar to the federal government, about 40 states have some direct, official governmentwide GI leadership component provided by statute or executive order. However, most of these directives are limited to encouraging GI coordination, and few establish programs or authorize large expenditures for coordinating activities. Few establish oversight, and few require commonality or accountability among agencies.

In addition to the state directives, state and federal agencies also are signing agreements to meet common GI goals, such as the one below in Utah.

Nine Federal Agencies and State of Utah Sign MOU for Data Sharing and Integration

On October 15, 1997, Utah's Governor Michael Leavitt signed a Memorandum of Understanding with the following federal agencies for the Utah Digital Spatial Data Sharing and Integration Project:

- Bureau of Land Management
- Forest Service
- Environmental Protection Agency
- National Park Service
- Natural Resources Conservation Service
- U.S. Army Corps of Engineers
- U.S. Bureau of Reclamation
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

Governor Leavitt declared at the signing ceremony that it "is a victory for common sense" since federal, state, and substate agencies commonly recognize they need and use similar data. According to John Moeller, Staff Director of the Federal Geographic Data Committee (FGDC), the MOU is the "first of a kind" signed at such a high policy-level among so many agencies and a Governor, and was encouraged by Interior Secretary Bruce Babbitt and other members of the FGDC Steering Committee.

Initiated as a "grass roots" effort by representatives of local, state and federal agencies, the MOU now established support from agency leaders and provides a mechanism to cooperatively create and share impartial and credible digital spatial data. It authorizes agency personnel to participate in cooperative data efforts and expands existing regional agreements or agency specific agreements to a statewide level for the purpose of data coordination and sharing. It is also expected to decrease duplication in data development, while generating standardized data for use by several agencies. Dennis Goreham, Manager of the Utah Automated

Geographic Reference Center (AGRC) said the MOU is fostering overall communication between federal, state and other agencies in Utah, and has significantly elevated policy-level involvement in GI by agency leaders. Significant aspects of the MOU include:

- Creation of agency specific data catalogs, all connected to the State GI Database maintained by the Utah AGRC,
- Adherence to the FGDC's Metadata Content Standard,
- Prioritization of 15 themes of data (geodetic control, digital ortho-imagery, elevation, transportation, hydrology, government units and boundaries, cadastral reference system and administrative ownership, demographics, wetlands, geology, wildlife habitat, climate, ground cover, land use, and soils) to create, integrate, and distribute through the State GI Database, and
- Coordination by signatories of data collection and standards dealing with attributes, accuracy, currentness, completeness, and other data elements through the Utah GIS Advisory Committee.

At the same time, all 50 states have at least one or more GI coordination groups, most formed officially, and others formed informally. Leadership varies considerably. For example, in some states, such as North Carolina and Virginia, agency directors are active members, while in other states, GI users are the active members.

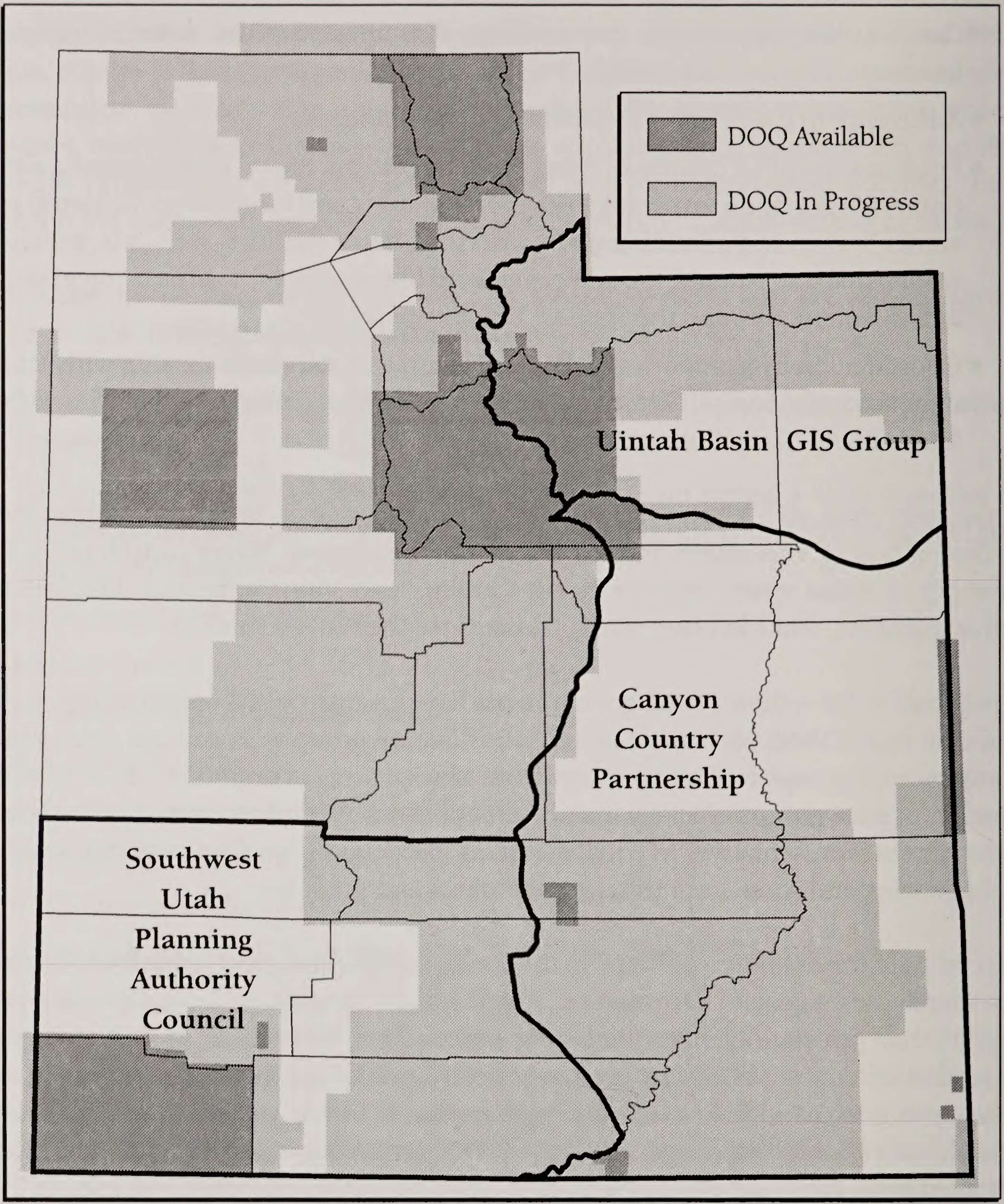
About half of the nation's local governments have an internal GI coordinating group, and over half of them participate in a GI coordination group with another jurisdiction. Many state GI groups involve members from a broad array of organizations. A growing number of state groups officially include other branches of government and non-state government representatives as equal members, particularly localities, utilities, and federal agencies, and some from tribal governments and academia.

Accordingly, the definition of "state" in the context of GI is the geographic area of a state, not merely state agencies. Decisions are made by and typically address a broader community than just state agencies, including some federal field offices. Moreover, there is a trend toward creation of separate but linked GI groups for individual sectors in specific states, such as a local or federal GI group, that in turn represent this sector to others. However, lack of interagency GI coordination among many federal field offices engaged in GI limits the effectiveness of these opportunities in many states.

FGDC evolved from efforts to reduce overlap and duplication in mapping, while most state and local GI coordination initiatives were formed to increase the availability of digital data to use with GI systems (GIS). While state GI coordinating efforts address many needs similar to those of the federal government (such as education, clearinghouse functions, and standard-setting), they increasingly develop common data that can benefit several state agencies, and often federal and local agencies, as well. In fact, several federal field offices participate in and contribute funding and data to these statewide efforts. For example, Figure 4-2 shows how local, state, and federal data needs are being met together for sub-state and state-wide needs in Utah.

Similar to the FGDC, state GI groups focused originally on natural resources data, but the proliferation of GIS use in other government functions and agencies at the state

FIGURE 4-2: LOCAL, STATE, AND FEDERAL AGENCIES COLLABORATE IN UTAH ECOREGIONS


DOQ Available
DOQ In Progress
Uintah Basin GIS Group
Canyon Country Partnership
Southwest Utah Planning Authority Council

Local, state, and federal officials agreed to work together on an ecoregional basis in three areas of Utah as shown. Collaborating organizations were formed of field-level representatives of federal and state agencies along with local government officials. These groups worked with the State of Utah's GIS Advisory Committee to determine data standards and priorities, including Digital Orthophotograph Quadrangles (DOQs). The map shows the boundaries of these three ecoregions and progress in DOQ production for the state as a result of these collaborative efforts. Data sharing agreements signed by members of the three groups led to a unique policy-level memoranda of understanding on October 15, 1997, between the State of Utah and nine federal agencies to collaboratively share and develop geographic data on a statewide basis.

level is expanding the scope of coordination and data collection efforts. In fact, all functions of state government are represented in one or more state groups.

State GI efforts also increasingly exhibit a stronger linkage to state central management agencies and functions than exists in the federal government. For example, state GI coordination can be driven specifically by the need for planning or growth management, coordinated environmental and natural resources activities, or other needs, often with authorized funding by, linkages to, and data sharing with local governments. In even more states, GI coordination is increasingly linked to overall information policy and/or information technology management agencies, as evidenced by the administrative location of state GI coordinators in such agencies.

Individual conditions in the 50 states vary considerably, and some of the advances discussed above are only evidenced in a minority of the states. Furthermore, while state GI coordination efforts have originated from internal and local needs, several have been nurtured by various efforts of FGDC and certain federal agencies. Leading states could assume additional coordinating roles regarding GI if additional direction and resources were available, but conditions in other states would likely require extensive federal intervention and resources to provide a common level of GI conditions across all 50 states.

Conclusion

Unless state and local governments are full, willing, and capable participants, NSDI is much less likely to be useful at all levels of government.

Recommendations

- **Designate states as major nonfederal FGDC partners and encourage development of a strategy for all states to have greater commonality of GI capacity and infrastructure.**
- **Re-examine the FGDC framework layers in the context of state and local GI needs as well as federal needs.**

FEDERAL REGIONAL COORDINATION INITIATIVES

Federal efforts have also been underway in various parts of the country to improve GI coordination, access, and utility. The leadership for many of these multi-state, regional efforts has involved federal land management agencies such as the Forest Service and BLM for locations with large federal land ownership, but other agencies as well, such as NOAA and EPA, are engaged in multi-agency and multi-level coordination for locations of relevance to their missions. Examples include the Chesapeake Bay, Great Lakes, Southern Appalachian Man and the Biosphere Cooperative, Gulf of Mexico, Pacific Northwest Forest Plan, and Columbia River Basin.

For the most part, these multi-state, regional efforts have had executive-level support and resources to meet the shared mission of providing better understanding and attention to environmental and/or natural resources conditions. Accordingly, leadership direction and support is provided to acquire, coordinate, and synthesize GI from several sources to derive a regional picture and develop alternative scenarios for policy decisions. For example, the President's Northwest Forest Plan provided impetus for federal land managers in the Pacific Northwest to move toward a common approach to manage this ecosystem. Data differences were identified early on this process, and efforts were made to reconcile them. The Interorganizational Resource Information Coordinating Council (IRICC), composed of federal and state GI representatives, was formed to help reconcile these issues and create a seamless database for the region. The unique Regional Ecosystems Office, located in Portland OR, was created with staff from federal agencies to serve as a clearinghouse of data from multiple sources and to help accomplish this goal. IRICC and similar regional initiatives do not have official roles, according to FGDC, but their efforts utilize FGDC standards and other direction.

RELATIONSHIP OF THE NSDI TO THE NATIONAL INFORMATION INFRASTRUCTURE AND THE INFORMATION TECHNOLOGY COMMUNITY

The National Information Infrastructure (NII) is a federal policy initiative to facilitate and accelerate the development and utilization of the nation's information infrastructure. The Clinton Administration envisions the NII as a seamless web of communications networks, computers, databases, and consumer electronics that will put vast amounts of information at users' fingertips. In general, the development of the NSDI was to occur within the overall policy and budget context of the NII and was not to be separate from it. The NSDI was designed to advance the goals of the NII, avoid wasteful duplication of effort, and promote effective and economic management of resources by federal, state, local and tribal governments. Many users regard GIS as an application area for the NII that is equal in importance and challenge to the better-known areas of education, health care, and community computing.

New uses for GI also are emerging. For example, within the Department of Commerce's Telecommunications and Information Infrastructure Assistance Program, matching grants are targeting on the rural and urban under-served populations to help them overcome various barriers to access and use of the emerging NII. These barriers may be technological, geographic, economic, physical, linguistic, or cultural. Many local government grant applicants have started including the use of GIS and Internet-based access to geo-referenced data on jobs, local transportation, or child care resources to help citizens and businesses.

Links to Recent Information Technology Reform Laws

Recent national legislation and federal executive orders have changed the decision environment related to the investment and management of all IT, including GIS. A key basis for this changed environment is a consensus that a government that works better and costs less requires efficient and effective information systems. The Paperwork Reduction Act Amendments of 1995 and the Information Technology Management Reform Act of 1996 (ITMRA) provide new opportunities to improve significantly the way the federal government acquires and provides access to information and manages IT.

E.O. 13011 implements these legislative changes by providing federal agencies the clear authority and responsibility to make measurable improvements in mission performance and service delivery to the public through the strategic application of IT. The executive order supports a coordinated approach that builds on existing structures and successful practices to provide maximum benefit from these technologies across the federal government. However, the order does not require common geographic referencing of tabular data, so there is a continuing problem with linking data across programs. Only EPA has a location data policy.

The specific impact on implementation of the NSDI is that, while there is no specific focus on the GIS applications or related standards and clearinghouse activities as outlined in E.O. 12906, the acquisition, use and management of GI-related hardware, software and telecommunications technologies, the creation and use of metadata, and the implementation of data standards all fall under the new decision environment of ITMRA. For example, federal agencies are expected to include the GIS aspects in their strategic plans to link with agency mission; to include GIS in their inventories; to calculate the return for investments in GIS; to engage in cooperative planning efforts with their partners; to acquire new GIS systems and upgrades to existing systems under the new acquisition reform provisions; and to be part of the oversight responsibilities of the new chief information officers and the new institutions of the CIO Council and the Government Information Technology Services Board.

Access America

The Clinton Administration released in January 1997 its *Access America Action Plan* to guide implementation of the NII within the federal government. Goal A04, "Bring Environmental Information To The Public," includes a specific action to expand the existing federal standard for describing geospatial data to include elements for describing biological information. The FGDC is charged with the responsibility to ensure that the elements for biological data are added to the existing standard by January 1998. Other key actions include:

- developing and maintaining a National Atlas of the United States.
- promoting the development and partnerships for the National Environmental Data Index (NEDI).
- initiating a broad effort to develop an "electronic national natural history museum."
- enhancing and expanding the Interagency Taxonomic Information System (ITIS).

FGDC is not closely connected to the administration's initiatives on the NII, although there a strong relationship between hardware and software for GI, the content and use of the NSDI, and the NII. The White House groups involved with the NII and federal IT have other, more urgent priorities and seem to defer to the FGDC on GI matters.

Recommendations for Immediate Action

- **Integrate federal GI more actively into the administration's NII initiatives and vice versa.**
- **Federal agencies need to incorporate GI and GIS and the NSDI concept into their overall information technology strategies and plans.**

ENDNOTES

[1] Vice President Al Gore, *Creating a Government the Works Better and Costs Less: Department of the Interior* (Washington, DC: GPO, 1993).

[2] Office of Management and Budget, *Circular No. A-16: Coordination of Surveying, Mapping, and Related Spatial Data Activities* (Washington, DC: OMB, 1990), p. 7.

[3] *Ibid.*, pp. 4 and 6.

[4] Executive Order 12906, *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure* (Washington, DC: The White House, 1994), p. 1.

[5] Office of Management and Budget, *Circular No. A-16,* p. 6.

[6] National Research Council, *Promoting the National Spatial Data Infrastructure Through Partnerships* (Washington, DC: National Academy Press, 1994), p. 23.

CHAPTER 5

Policy Bases, Structure, and Organization to Meet Today's and Tomorrow's Geographic Information Challenges and Opportunities

The federal government has been engaged in GI functions since the beginning of the Republic. Expansion of U.S. territory and settlement of the lands west of the original 13 colonies was a major function of government during the 18th and 19th centuries. This included development of the basic maps and land boundaries needed to make such settlement possible. Requirements for industry and commerce also entailed the creation of base data about the coastal waters and harbors to facilitate shipping and provide for safe navigation.

Federal agencies, such as the General Land Office and the Coast & Geodetic Survey, were created to respond to these needs. Additional requirements to develop information for mineral exploration and scientific investigations led to the creation of the U.S. Geological Survey and, with it, the capacity to define and create a national database of maps and, more recently, photographic images of the U.S. land mass.

National defense requirements also led to creation of GI capabilities in the Army, Navy, and Air Force that were consolidated into the DMA in 1972; classified remote-sensing and imaging capabilities in the intelligence agencies; and, recently, to creation of NIMA within the DoD. Other DoD components, such as the Army Corps of Engineers (ACE) and military installations are also extensive users of GI. Because the United States has been fortunate to have avoided war on its own land mass for most of its history, DoD has largely limited its GI activities to territory outside of U.S. borders. USGS has had an agreement with DMA (now NIMA) for several years to supply defense needs for GI over the United States, as required.

Other civilian agencies have also needed a variety of geographic data to meet their mission needs. With the advent of automated GIS, agencies' capacities to create, customize, and distribute GI for their own purposes have proliferated. Earlier studies of surveying and mapping activities identified 39 federal agencies with significant GI activities; that number has grown over the years.[1] Nearly every department and major federal agency now has requirements for geographic data, and the development and use of such data is expected to grow.

The NRC's MSC concluded in 1993 that the NSDI's effectiveness will depend more on institutional arrangements than on technology. The committee's report said: "Without coordination of many different organizations and without leadership at the federal level, the NSDI will be reduced to a series of projects of limited value and life span." [2] (This was consistent with the approach taken in Circular A-16 establishing the FGDC.) MSC outlined a new strategy which included the following elements:

- obtain and maintain national commitment
- evaluate requirements, constraints, and opportunities
- determine priorities
- develop coordination mechanisms and organization structures
- assign roles and responsibilities.

For this study, the Academy Panel was asked to answer questions on the appropriate roles of the federal government in GI, and opportunities to consolidate or otherwise restructure federal GI functions to achieve greater economy and performance, including which functions should be brought together and how they should be structured. This chapter provides the Panel's response.

THE LARGER CONTEXT OF FEDERAL LAND AND WATER MANAGEMENT RESPONSIBILITIES

Federal land and water management responsibilities are spread among numerous departments and agencies. The DOI manages the majority of federal land holdings, followed by the USDA, primarily in the Forest Service. The Department of Commerce's NOAA has the primary responsibility for coastal zone and continental shelf program management. NOAA has commerce, navigation, living marine management, and fisheries duties. Commerce's Bureau of the Census is a major GI user because of the requirements of the decennial census. The DoD has smaller but still substantial land holdings about equal to the size of New England in the form of military ranges and bases. DoD is a major player in GI through the ACE and NIMA. The latter is focused on land outside of the United States but has needs for spatial data from the NSDI.

At the federal level, much of the "overlap and duplication" in GI functions cited in earlier reports was simply a function of the various land and water management agencies having established the capacity to produce GI of one sort or another to meet their individual program needs. To the extent that such agencies or their departments and programs were consolidated, opportunities would be provided to consolidate GI functions as well. While the scope of this study is narrower than overall departmental organization questions, it is worth noting the impact that any major programmatic, agency, or departmental reorganization would have on federal GI functions.

Over the years, there have been a number of proposals for legislation to consolidate some land and water management functions into a department of natural resources (DNR) but they have never been enacted. In 1995, bills were introduced to abolish the Department of Commerce and three other federal departments. One version of the Commerce bill would have transferred geodesy functions to the DOI.[3] Proposals also have been made to transfer the Forest Service to the DOI or, conversely, to transfer the BLM to the USDA.

In June 1996, the Senate Committee on Governmental Affairs held a hearing on improving the management and organization of federal natural resources and environmental functions.[4] Academy Fellow Alan Dean testified[5] in favor of restructuring federal land management agencies, either by creating a DNR along the lines recommended by President Richard Nixon in the early 1970s or, failing that, by transferring the Forest Service to the DOI. Dean said:

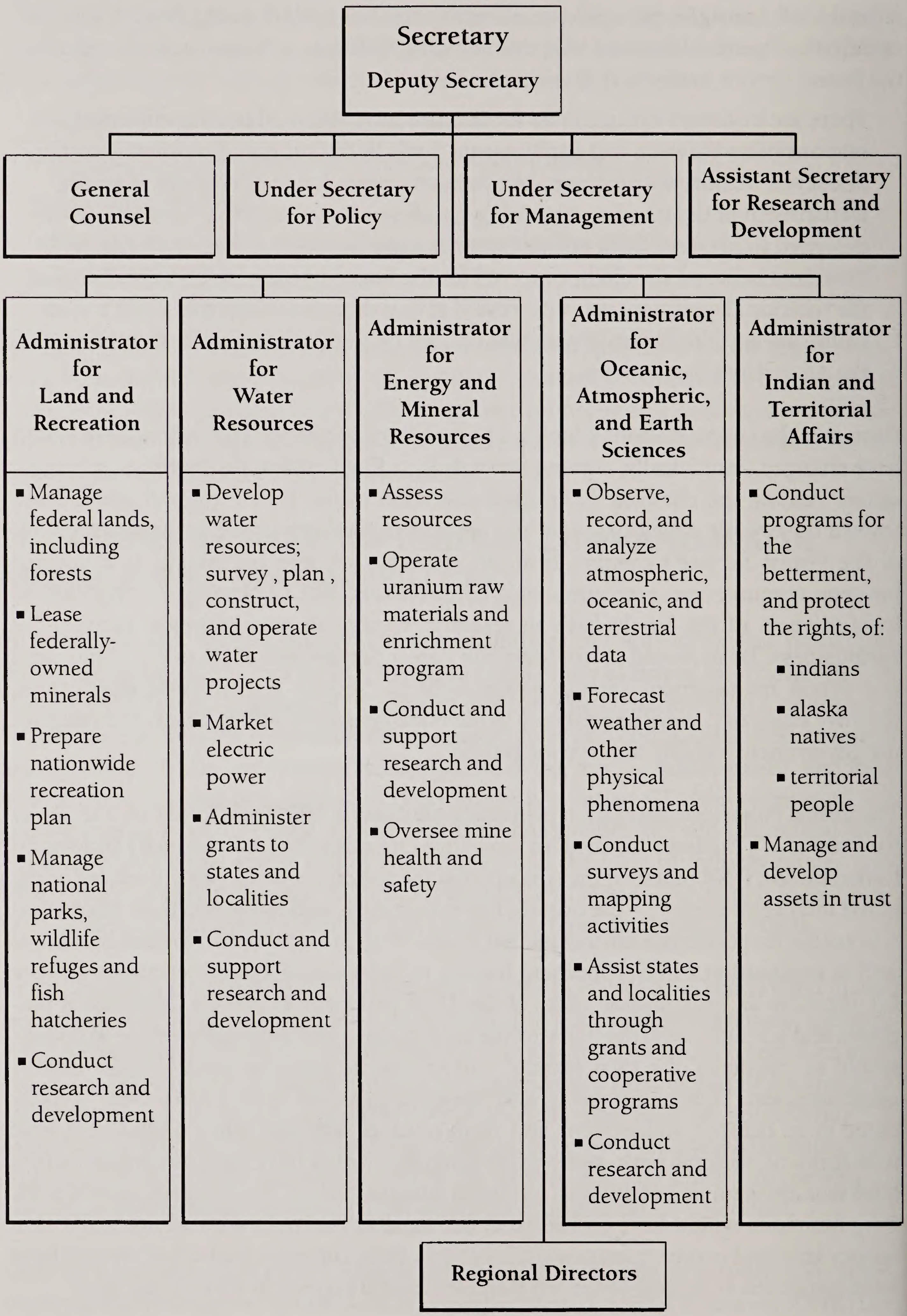
> There are historical explanations for the current division of land management responsibility between two departments. Early in the century, President Theodore Roosevelt withdrew from the public domain certain lands administered by the Department of the Interior containing significant forest reserves. This action was designed to preserve from sale or indiscriminate harvesting, forests which the President believed should be reserved for the future needs of the Nation. Because the Interior Department was not trusted at that time to act effectively as a conservation agency, the Forest Service was created by the Congress in 1905 as an arm of the Agriculture Department.

Dean said the considerations which led to the placement of the Forest Service in USDA have changed dramatically, arguing strongly for a fresh look at the merits of this separation. Among the changes: (1) radical alteration of the DOI's mission and culture toward the orderly development of the nation's natural resources, (2) transformation of the Forest Service's mission from an emphasis on tree harvesting to a balance between resource use, recreation, and conservation, and (3) changes in agriculture from support of the family farm to research, regulation, and technical support for agribusiness. Dean would consolidate the Forest Service and BLM into a single land and forest management service within DOI to "reduce bureaucratic duplication, improve efficiency, foster consistency in the management of public lands, and enhance the government's ability to serve the public."

The formal Nixon reorganization proposal published in 1972[6] was based on a study by the President's Advisory Council on Executive Organization (Ash Council) and would have created a DNR based on the concept that the nation needed a better understanding of the total environment – the oceans, the atmosphere, and lands and their interaction – to enable more effective environmental monitoring, prediction, and limited control, as well as exploration and development leading to fuller use of natural resources. (Figure 5-1 provides an organization chart of the DNR proposed in 1972.) Operational programs and scientific investigations for the land, oceans, and atmosphere were to be integrated as "elements of a total system," rather than as separate entities under diverse administration. Federal surveying and mapping activities would have been consolidated in an oceanic, atmospheric and earth sciences administration while forest, land management, national park, and wildlife programs would have been administered by a land management and recreation resources administration. Thus, surveying and mapping functions would have ended up in the same department with all the major civil agency land and oceans management functions. Field components for both would have been organized according to the ten standard federal regions in effect at the time.

The Academy considered and endorsed the Nixon proposals in 1972, but they faded away with the demise of his administration. President Jimmy Carter also proposed a DNR in 1979 as one product of his major reorganization initiative, but it also was never enacted. Subsequent administrations lost interest in department-level reorganization

FIGURE 5-1: PROPOSED DEPARTMENT OF NATURAL RESOURCES


Secretary
Deputy Secretary
General Counsel
Under Secretary for Policy
Under Secretary for Management
Assistant Secretary for Research and Development
Administrator for Land and Recreation
▪ Manage federal lands, including forests
▪ Lease federally-owned minerals
▪ Prepare nationwide recreation plan
▪ Manage national parks, wildlife refuges and fish hatcheries
▪ Conduct research and development
Administrator for Water Resources
▪ Develop water resources; survey , plan , construct, and operate water projects
▪ Market electric power
▪ Administer grants to states and localities
▪ Conduct and support research and development
Administrator for Energy and Mineral Resources
▪ Assess resources
▪ Operate uranium raw materials and enrichment program
▪ Conduct and support research and development
▪ Oversee mine health and safety
Administrator for Oceanic, Atmospheric, and Earth Sciences
▪ Observe, record, and analyze atmospheric, oceanic, and terrestrial data
▪ Forecast weather and other physical phenomena
▪ Conduct surveys and mapping activities
▪ Assist states and localities through grants and cooperative programs
▪ Conduct research and development
Administrator for Indian and Territorial Affairs
▪ Conduct programs for the betterment, and protect the rights, of:
▪ indians
▪ alaska natives
▪ territorial people
▪ Manage and develop assets in trust
Regional Directors

Source: Office of Management and Budget, *Papers Relating to the President's Departmental Reorganization Program, 1972.*

as a practical tool of management reform, and Congress has not enacted any of numerous proposals introduced by its members, although there have been many new entities created, a few abolished, and a multitude of program transferred.

The Panel for this study neither endorses nor opposes any of the natural resource or land reorganization proposals discussed above. It simply notes the long-standing interest in consolidation of land management and other natural resource functions and that any future consideration of natural resource agency reorganization would provide an opportunity to consolidate support functions, such as those involving GI.

BUILDING THE POLICY BASE AROUND A NEW NATIONAL COMMITMENT TO THE NSDI

The laws and regulations authorizing individual agency GI activities have evolved since the beginning of the Republic, and a surprising number of these authorities are either very broadly written or date back more than a century, or both. Each agency has its own mandates, some authorizing development and provision of base data used not only in government but throughout society, and others involving specific missions for which GI is required to fulfill such missions.

Few new laws have been written in this field during President Clinton's term in office. Instead, the administration has chosen to rely on executive orders, annual budgets, and internal planning initiatives to define GI policy. Project staff have been advised that Interior Secretary Bruce Babbitt has chosen to keep the FGDC and NSDI "low key and out of politics." While this strategy has enabled some quiet progress to be made, it has not engendered national attention to, or debate on, the merits of an NSDI or its cooperative multi-agency, multi-sector strategy for building a national framework of geographic data. There is license to proceed but no national mandate.

Some of the laws authorizing individual agency GI functions are summarized below.

Bureau of Land Management (BLM)

The 1785 Land Ordinance Act provided for the survey and settlement of lands that the original 13 colonies ceded to the federal government after the War of Independence. A surveyor from each state took an oath before the geographer of the United States; this was done in reaction to many fraudulent surveys, resulting in land disputes, that were done during colonial times. The U.S. geographer, representing federal authority to supervise the work, was in charge of the surveyors.

The 1872 Mining Law authorizes a $32-million program that is entirely cost-reimbursable, and it interacts with the Federal Lands Policy Management Act and the Resources Act. A revision of an 1866 law, it has been amended 34 times and is made up of four major components:

- Mining claims reporting, maintenance ($5 million annual program); approximately 300,000 mining claims are active or in good standing.
- The surface management program ($15 million annually) deals with mine permits and reclamation.

- Mineral patenting, a small part of the law ($2 million annually), deals with adjudication and field examinations.
- Miscellaneous provisions include those relating to inventories, mineral exams not related to patents, and fishing.

The 1976 Federal Lands Policy Management Act makes BLM responsible for the balanced management of the public lands and resources and their various values so that they best serve people in the United States. Management is based on the principles of multiple use and sustained yield; a combination of use that takes into account the long-term needs of future generations for renewable and non-renewable resources. These resources include recreation, rangeland, forest, minerals, watershed, fish and wildlife, wilderness, and natural, scenic, scientific, educational, and cultural values.

U.S. Geological Survey (USGS)

The Organic Act of 1879 (43 USC 31; amended in 1962 and restated in annual appropriations acts) directs the USGS to classify public lands and to examine the geologic structure, mineral resources, and products inside and outside of the national domain. It also establishes the position of the director of the Geological Survey, who is appointed by the President with the advice and consent of the Senate. The director is to classify public lands and examine geological structure, mineral resources, and products of the national domain and outside of the national domain where determined by the secretary to be in the national interest.

The Land Remote Sensing Policy Act of 1992 (15 USC 5652) assigns responsibility for the National Satellite Land Remote Sensing Data Archive to the DOI, through the USGS EROS Data Center, and authorizes the DOI and others to conduct research and development programs in applications of these data. It is to provide data continuity for the Landsat program.

The National Geologic Mapping Act of 1992 establishes the National Cooperative Geologic Mapping Program within the USGS and defines its composition and objectives.

Distribution of maps and atlases. 43 USC 42 authorizes and directs the director of the Geological Survey, upon the approval of the secretary of interior, to distribute topographic and geologic maps and atlases of the United States and to fix purchase prices for them. A number of maps (no more than 500) are to be distributed gratuitously to foreign governments and federal departments, literary and scientific associations, and educational institutions and libraries designated by the director.

Forest Service

Surveying

The Organic Act of 1897 (16 USC 474) delegates to the chief of the Forest Service the authority to identify, define, administer and manage National Forest System lands and resources, requiring the Forest Service to make or acquire both administrative and legal surveys. A copy of every topographical map and other maps showing distribution of the forests shall be certified by the director of the Survey and filed with BLM.

Federal Survey Authority

The Townsite Act Authority of 1958 (16 USC 478a) provides the Forest Service authority to locate and describe parcels of land as part of the conveyance process. It provides that when the secretary of agriculture determines that a tract of National Forest System land in Alaska or in the 11 contiguous western states is located adjacent to or contiguous to an established community, and that transfer of such land would serve indigenous community objectives that outweigh the public objectives and values which would be served by maintaining such tract in federal ownership, the secretary may set aside and designate as a townsite an area not to exceed 640 acres of National Forest System land for any one application.

After public notice, and satisfactory showing of need by any county, city, or other local governmental subdivision, the secretary may offer such area for sale at a price not less than the fair market value.

The Small Tracts Act Authority of 1983 (16 USC 521c-d) provides the Forest Service authority to survey, monument land corners, mark and post property lines, and describe parcels of land as a part of the conveyance process. The secretary of agriculture is authorized, when it is in the public interest, to sell, exchange, or interchange by quitclaim deed, all right, title, and interest of the United States in and to National Forest System lands described in section 521e (small parcels) of this title.

Individual State Authority

The Federal Land Exchange Facilitation Act of 1988 (43 USC 1716) requires the Forest Service to consult with other federal agencies concerning the needs, costs, and benefits associated with improvements in existing methods used for land surveying and mapping. A tract of public land within the National Forest System may be disposed of by exchange with the secretary of agriculture where the secretary considers the public interest.

16 USC 1604 provides for the development, maintenance, and as appropriate, the revision of land and resource management plans by the secretary of agriculture for units of the National Forest System, coordinated with the land and resource management planning processes of state and local governments and other federal agencies. Maps and other descriptive documents should be included as part of the written material for the plan.

36 CFR 219.12d establishes planning criteria that require the collection, assembly and use of data, maps, graphic material, and explanatory aids, of a kind, character, and quality, and to the detail appropriate for management decisions to be made.

36 CFR 293.4 provides for wilderness and primitive areas and requires the Forest Service to establish uniform procedures and standards for the maintenance and availability to the public of records pertaining to the National Forest Wilderness, including maps and other related documents.

Mapping (Geometronics)

5 USC 301 and FSM 7140.1 gives the secretary of agriculture the basic responsibility and gives responsibility for coordination of all USDA mapping work to the chief of the Forest Service by the assistant secretary for natural resources and environment through 7 CFR 2.60a10.

7 USC 1387 provides the basic authority for sale of photographic reproductions and maps.

Remote Sensing

FSM 7145.4 assigns responsibility to the deputy chief, National Forest System, to be responsible for the development, coordination, and technology transfer of remote sensing activities.

Geographic Information Systems (GIS)

FSM 6619 establishes policy responsibilities for the acquisition and implementation of GIS technology, identification of requirements for geospatial data, and the management of resource information. The GIS Center of Excellence is using the National GIS Plan of 1988 to coordinate the formulation of a service-wide GIS implementation strategy to meet present operational needs.

NOAA's National Ocean Service (NOS)

33 USC 883a authorizes the secretary of commerce to provide charts and related information for the safe navigation of marine commerce and commercial aircraft and to provide basic data for engineering and scientific purpose and for other commercial and industrial needs. Activities include hydrographic, topographic and geodetic control surveys and tide and current observations.

Aeronautical Charting and Cartography

33 USC 883a authorizes the secretary of commerce (through NOAA) to conduct field surveys for aeronautical charts, as well as a number of other surveys, for the safe navigation of marine and air commerce, and to provide basic data for engineering and scientific purposes and for other commercial and industrial needs.

33 USC 883b. Authorizes the secretary of commerce (through NOAA) to compile, print, and distribute aeronautical charts of the United States, its territories, and possessions and international airways.

44 USC 1307 authorizes the secretary of commerce to annually establish and to adjust prices for aeronautical products created or published by NOAA. It provides that the secretary of commerce may distribute nautical and aeronautical products to any foreign government or international organization without charge if they have agreed on the exchange of these products free of charge. The secretary of commerce may distribute products to departments and officers of the United States requiring them for official use at prices the secretary establishes.

Act of April 5, 1960 (P.L. 86-409), enacted to clear up misunderstanding about a 1947 law, eliminated all real or ambiguous restrictions on the geographical scope of the area in which the Coast and Geodetic Survey was authorized to operate. It clarified that the survey was authorized to carry out its activities without regard to geographical limitation whenever the head of an executive agency determines the project to be essential to the national interest.

33 CFR 164.33, Navigation Safety Regulations, charts and publications, requires that each vessel must have marine charts published by NOS, ACE, or a river authority meet-

ing certain criteria. A marine chart published by a foreign government may be substituted for a U.S. chart and publication.

Legislative Proposal

The Clinton Administration proposed to transfer NOAA's Office of Aeronautical Charting and Cartography to DOT.[7] The first step requires NOAA to operate the program for DOT in 1998 on a reimbursable basis, and the program will be completely transferred to the DOT's Transportation Administrative Service Center in 1999.

National Imagery and Mapping Agency

10 USC 2792 authorizes the secretary of defense to have DMA (now part of NIMA), which was established by order of President Richard Nixon in 1971, prepare maps, charts, and aeronautical books required in navigation and have those materials published and furnished to navigators.

The National Defense Authorization Act for Fiscal Year 1997 established NIMA as a DoD agency with the primary goals of ensuring visibility and accountability for geospatial information resources, and harnessing, leveraging, and focusing rapid technological developments to serve the imagery, imagery intelligence, and geospatial information customers, primarily in the defense and intelligence communities. Among its other objectives, this law requires that NIMA "improve [the] means of navigating vessels of the Navy and merchant marine by providing. . .accurate and inexpensive nautical charts, sailing directions, books on navigation, and manuals of instructions of all vessels of the United States and *of navigators generally*." [viii] (Italics supplied.)

A myriad of other laws authorize or otherwise affect GI and GIS in the federal government. In addition to the Results Act discussed in Chapter Four, federal GI functions must take into account laws on freedom of information, privacy, patent and copyright protection, procurement, national security, and IT. As noted earlier in Chapter Four, many states also have enacted laws on GI, the most recent of which, in Virginia, established a division for GI and a state GI council.

This sampling of the laws authorizing federal land management and other GI-related programs, as well as authorizations for GI functions themselves, shows the wide variation in time span and level of specificity for the mandates under which these programs operate. None of the laws, with the possible exception of the Land Remote Sensing Policy Act of 1972 and the more recent statute establishing NIMA, anticipates a world in which geographic data can be created from satellite images, location can be determined anywhere in the world using global positioning satellites, and vast quantities of data can be stored and transmitted almost instantly and electronically.

Circular A-16 and E.O. 12906 provide sound, substantive foundations for federal GI functions and activities and the development of the NSDI, but they are backed only by a complex and largely outdated mix of federal laws, the history and evolution of federal organizations and programs, and the communities and professions which provide GI and GIS products and services to governments and the general public. As discussed elsewhere in this report, the Panel believes that good progress has been achieved and more can be attained, but a national mandate for the NSDI, the broader changes in organizational behavior required for multiple GI databases with regional or nationwide coverage, and a reconciliation of the disparate GI functions performed by numerous federal agencies would be facilitated by means of the new statute. The topics to address addressed in such statute include:

- a list of congressional findings about GI
- a statement of national goals and definition for the NSDI
- a charter for the NSDC
- consolidation of federal base GI functions
- modifications to existing law to facilitate GI partnerships, CRADAs, and private-sector procurements
- amendments or rescissions of current law to modernize and conform existing program authorizations to the NSDI concept.

The process for enacting any such statute will take months and probably years before the new law is on the books. While such process can begin in either Congress or the executive branch, the Panel believes the latter is best positioned to develop an initial draft in consultation with the GI community. This report can provide a starting point. If consensus can be reached in the community and the public can be made aware of the benefits achievable by means of a robust NSDI and a stronger federal GI service agency, Congress likely would be receptive. As Congress becomes more aware of GI and GIS potential for analysis of national and global problems and support for decisionmaking, it should also become more receptive to legislation supporting an NSDI. Meanwhile, there are many other actions outlined in this report that should be taken without waiting for a bill to be drawn or Congress to act.

Conclusions

Based on its review of the policy bases summarized above, the Panel concludes that:

- Although well-conceived, Circular A-16 and Executive Order 12906 are relatively weak policy bases, compared with mandates having the force and effect of law, for fulfilling goals as ambitious as those set for the NSDI. Neither the circular nor the executive order require executive agencies to consolidate any activities or share capacities. Budget reductions and calls in Congress to cut back or abolish these agencies have provided the primary incentives; neither provides a policy foundation for building the NSDI.
- Agency attitudes about their missions, functions, and customers indicate that existing statutes enacted decades or centuries ago serve more to sustain current activities than provide a base for new ways of doing business that is enabled by modern technology and needed to build the NSDI. (Forest Service noted that legislation enacted over the years directing the federal land management agencies does not preclude them from using the most advanced technologies for GI, and they have attempted to do so where it complements and supports land and resource management objectives.)
- New laws, such as GPRA and ITMRA, provide opportunities to better coordinate GI activities and facilitate access to private-sector capabilities needed for the NSDI.

Recommendation

- **The administration should draft a new statute in cooperation with state and local governments and other organizations to create an NSDI, estab-**

lish a National Spatial Data Council, and better define federal agency roles and responsibilities for NSDI so as to meet the participating organizations' programmatic needs.

CIVIL AGENCY MISSIONS, ORGANIZATIONS, AND CULTURES

Several federal agencies are engaged in activities that provide the foundation or affect the availability and compatibility of base geographic data. Their histories, program functions, operating practices, use of technology, and cultures differ markedly. The four agencies which sponsored this study are outlined below.

Bureau of Land Management (BLM)

BLM administers public lands within a framework of numerous laws. The most comprehensive of these is the Federal Land Policy and Management Act of 1976 (FLPMA). All Bureau policies, procedures and management actions must be consistent with FLPMA and the other laws that govern use of the public lands. BLM is to sustain the health, diversity and productivity of the public lands for the use and enjoyment of present and future generations.

BLM is responsible for the management of about 270 million acres of public lands, mostly in Western United States and Alaska. BLM is also responsible for subsurface resource management of an additional 300 million acres, where mineral rights are owned by the federal government. Resources managed by BLM include timber, solid minerals, oil and gas, geothermal energy, wildlife habitat, endangered plant and animal species, rangeland vegetation, recreation and cultural values, and conservation and wilderness areas.

BLM has a cadastral survey program[9] whose mission and focus includes:

- performing legal boundary surveys for the federal government, including consultation and boundary determination expertise for Forest Service, National Park Service, ACE, Bureau of Indian Affairs, FWS, and Bureau of Reclamation
- stewardship of PLSS records for all active Public Land States, descendant from original General Land Office, or the GLO, the creators of the PLSS

Although they are said to be core functions, PLSS and cadastral survey functions are only a small part of BLM's total operations and apparently are given relatively low priority. The culture is steeped in tradition with strong ties to the rectangular survey system predominant in the West.

Survey activities are focused on resolving boundary disputes and making boundary determinations necessary for land transfers, leaving less capacity to fulfill longer-term goals, such as filling out the Geographic Coordinate Data Base (GCDB). BLM also is unable to do much to service the surveying needs of other land management agencies*, although potential exists to achieve some economies by consolidating other agency surveying staffs with BLM's.

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*About 15 percent of BLM's work is done on a reimbursable basis for other agencies, such as the National Park Service, Bureau of Indian Affairs, and Bureau of Reclamation.

BLM also is the custodian of the public land records for the U.S. government. Over the years BLM developed a land records system using a microfilming process, but it is now automating these records (see below). Title to about 1.1 billion acres has been transferred over the nation's history to citizens, businesses, and other governments under federal legal authority generally referred to as the "land laws." Substantial portions, amounting to over 287 million acres, were removed from federal ownership under the authority of the Homestead Laws. Another 328 million acres were granted to states to help support public schools, develop transportation systems, and promote general economic development.[10]

In performing these functions, BLM maintains over one billion documents, including land surveys and surveyors' notes, tract books, land patents, mining claims, oil and gas leases, and land and mineral case files. According to BLM, many of these documents are deteriorating, and some are illegible. Most of them are manually maintained and stored in several locations, although some have been entered in various databases since the 1970s.[11]

For lands it manages, BLM develops land-use plans to balance multiple uses and competing demands, including ecosystem management, timber harvesting, mining, oil and gas production, watershed management, wildlife management, and recreation. It also designates and maintains land of critical environmental concern and is responsible for the cadastral layer of the FGDC's framework.

The installation of an Automated Land and Mineral Record System (ALMRS) may help improve technology use and coordination, but the initiative has had major problems and delays; it also is incompatible with other agencies' automated systems or those of state and local governments. GAO reported in March 1997[12] that BLM was beginning deployment of ALMRS in fiscal 1997 after development and testing are complete but the agency would not be ready to deploy until it had also completed essential management plans, policies, and procedures to help ensure a successful transition and operating environment.

DOI has stated that it intends to use ALMRS as the core system to support its land management responsibilities. According to GAO, as geographic capabilities and data are developed over time, the department expects ALMRS to provide the automated land ownership and use information to support all of its bureaus. After BLM, the Bureau of Indian Affairs (BIA) has the largest requirement for automating land titles and other land records. BIA appears to be moving toward using ALMRS to meet its land records needs, although modifications to ALMRS would be necessary.

BLM has some interesting and growing relationships with other federal agencies, primarily the Forest Service, and with state governments. For example, to aid implementation of the President's Northwest Forest Plan, BLM's Oregon office is working with the Forest Service regional office there to collocate their staffs and share GI resources to the extent permitted by their separate but related organizations and missions.

Forest Service

The essence of the Forest Service mission is embodied in its motto, "Caring for the Land and Serving People." The agency manages the national forests and grasslands under a sustained multiple-use concept to meet the diverse needs of the people. To accomplish its mission, the Forest Service is committed to activities that help ensure sustained health, biological diversity, and productivity of ecosystems. The agency also provides technical and financial assistance to state, private, and other federal land managers, including rural and urban communities. It provides the scientific and technical knowledge needed to protect and sustain forests and rangelands, and provides global leadership in sustainable development through international technical cooperation and scientific exchanges.

The Forest Service manages the 191.6 million acre National Forest System; carries out a comprehensive forest research program; and provides cooperative assistance to states, communities, and private forest land owners. In carrying out this mission, the Forest Service uses long-term strategic direction as required by the Forest and Rangeland Renewable Resources Planning Act (RPA). The Forest Service's commitment is to meet public demands for multiple benefits and to assure the sustainability of forest and rangeland ecosystems by ensuring their health, diversity, and productivity.

Forest Service Geometronics, the agency's formal mapping organization, dates back to its regional mapping offices of the 1930s.[13] These offices were part of the agency's engineering community and were often referred to as the Surveys and Maps Branch. In 1975, the Forest Service consolidated a large part of its geometronics organization at one location and established a national service center – the Geometronics Service Center (GSC) in Salt Lake City UT. A detached unit of Washington Office Engineering, its mission is to produce base maps and derived-map products, feature data (cartographic feature files), elevation data (digital elevation models), image data (digital orthophoto quads), and metadata. GSC also provides related training and technical assistance, and serves as a clearinghouse for geospatial products. Through the GSC, the Forest Service coordinates map revision activities with USGS. In this manner, it performs many of the same functions as USGS, but it compliments rather than duplicates them with regard to Forest Service lands.

Forest Service boundary management is a collection of activities which defines and protects the extent of the public estate and public interest in National Forest System lands. This includes surveying, marking, and description of the Forest Service's lands and boundaries. Forest Service land surveyors contribute directly to land title and land law work, land exchanges, land descriptions, and title details for land ownership adjustment.

The Forest Service culture is undergoing significant change as revenue sources and activities move away from timber production and more toward recreation and land preservation. There is growing awareness in the West of the need to cooperate with others in managing ecosystems and watersheds which cross agency and political boundaries, but current systems and management practices are not well-suited to joint projects and data exchange. Program activities are heavily decentralized at forest and district levels which inhibits development and use of common data bases either within the Forest Service, with other agencies, or with state and local governments.

The agency has extensive GI capacities, but they are largely self-contained in their goals, strategies and customer base, that is, they are strongly focused on meeting Forest Service program needs. As noted above, geometronics activities are housed in the Engineering Division and maintained relatively separate from IT and GIS activities elsewhere in the Forest Service. The Project 615 computer modernization promises stronger data processing and communications capacities, but there are some problems with processing speed for GI activities.

U.S. Geological Survey (USGS)

USGS is a natural science organization that is recognized worldwide as scientifically credible, objective, and demonstrably relevant to society's needs. The Survey's mission is to provide the nation with reliable, impartial information to describe and understand the earth.[14] This information is used to:

- minimize loss of life and property from natural disasters
- manage water, biological, energy, and mineral resources
- enhance and protect the quality of life
- contribute to wise economic and physical development

The mission of the USGS National Mapping Program (NMP) operated by the National Mapping Division (NMD) is to meet the nation's need for basic geospatial data, ensuring access to and advancing the application of these data and other related earth science information for users worldwide.[15] In support of this mission, NMP:

- ensures the production and availability of basic cartographic and geographic spatial data of the nation
- coordinates national geospatial data policies and standards
- provides leadership for the management of earth science data
- acquires, processes, archives, manages, and disseminates land remote-sensing data of the earth
- improves the understanding and application of geospatial data and technology in the resolution of environmental, societal, and other issues

NMD appears to be the strongest and most advanced technologically among the civilian mapping agencies, but it is very much a structured, top-down organization with fairly rigid organizational culture. The agency is going through significant cultural change in two ways: (1) placing much greater reliance on outsourcing to fulfill its mission, and (2) converting from staff adept at creating paper maps to one adept at using electronic technology. However, its products and services are still determined by the needs of other DOI offices and its traditional customer base with less direct focus on the broader challenges of creating and maintaining an NSDI.

NMD's field structure, as noted below, is not well-suited to easy and frequent interaction with state GI activities, although it is making some progress in establishing state liaisons. Product specialization of the field centers may make it difficult to convert to different product lines and service activities needed for the NSDI.

NOAA's National Ocean Service (NOS)

NOS is the primary civil agency within the federal government responsible for the health and safety of our nation's coastal and oceanic environment. As part of NOAA, NOS provides a wide range of products and services, established on the best scientific basis, for the protection of life, property, and the environment. The three NOS offices heavily involved in GI functions are:

Office of Aeronautical Charting and Cartography (AC&C)

AC&C is responsible for providing safe and accurate navigational charts to civil and military users, and controllers of the U. S. National Airspace System.[16] To accomplish its mission, AC&C plans and directs the construction; maintenance; reproduction; and distribution of aeronautical charts, products, and digital data files of the United States and its territories to meet the requirements of civilian and military aviation. More than 10,000 different aeronautical charts and related products are produced annually, and over 12,000,000 copies of charts are distributed annually for aeronautical navigation use. These publications are produced on strictly maintained printing cycles, some as brief a period as 28 days.

AC&C is to be transferred to the DOT beginning in fiscal year 1999.

Office of Coast Survey (OCS)

This office provides for the production of nearly 1,000 nautical charts of U.S. coastal and oceanic waters. Manned by a highly skilled cartographic workforce, this office constructs and maintains nautical charts in a variety of scales and in a number of differing formats. The Coast Survey is the nation's oldest scientific agency, established as the Survey of the Coast in 1807 by President Thomas Jefferson. Nautical charts are a fundamental tool and provide basic data for the safe navigation of marine commerce and are used by commercial and military mariners, fishermen, recreational boaters, local and state agencies, builders and coastal planners. This digital data is becoming increasingly in demand as ocean resources become more valuable.[17]

National Geodetic Survey (NGS)

NGS develops and maintains the National Spatial Reference System (NSRS) using advanced geodetic, photogrammetric, and remote-sensing techniques. NSRS is a consistent national coordinate system that defines latitude, longitude, height, and gravity throughout the nation, and the changes of these with time.* This information is essential for ensuring the reliability of transportation, communication, and defense systems; boundary and property surveys; land record systems; mapping and charting; public utilities; coastal zone management; natural resource mapping; and a variety of scientific and engineering applications. NGS maps the nation's coastal zone and waterways, and conducts research and development programs to improve the collection, distribution, and use of spatial data. NGS also provides federal leadership in developing specifications and standards for conducting geodetic surveys; coordinates the development and application of new surveying instrumentation and procedures; and assists state, county, and municipal agencies through a variety of cooperative programs.[18]

The Coastal Services Center, a coastal science and resource advisory center that addresses critical coastal resource issues, is also heavily involved in GI functions, as are divisions in the Office of Ocean Resources Conservation and Assessment.

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* NIMA developed the World Geodetic System (WGS), currently designated WGS-84, which maintains the Global Spatial Reference System. This is the reference system used for GPS. There is close coordination between the WGS and the North American Datum maintained by NGS.

NOS Culture and Performance

NOS is a solid performer in the work it accomplishes, but until recently it has been short on the resources needed to keep up with both its workload and technology. There are some early signs of more congressional support for its funding needs; however, as of this writing, it is too soon to tell whether sufficient resources are in the offing to enable it to reduce its backlog and acquire needed equipment and technology.

NOS is influenced by the traditions of nautical charting and its customer base, but it is becoming increasingly challenged by, and responsive to, the demands for products relying on digital technology, such as vector charts. (Also see Chapter Seven.)

There is some use of the private sector through CRADAs and contracting, but some agency staff express reservations based on past experiences about private-sector capabilities to assume a much larger share of its workload. Nevertheless, NOAA, NOS, and the Coast Survey have stated on the record that they expect 50 to 75 percent of all hydrographic surveying to be performed through outsourcing by the year 2000. Coast Survey is also experimenting with closer local and regional connections on the West Coast and in Florida with regard to multiple uses of nautical charts for economic and environmental needs. There is a strong push from the coastal and ocean resources management community for access to these data.

Other NOS programs utilize and apply advanced GI, and their staff advises that they have been in the forefront of developing GIS applications.

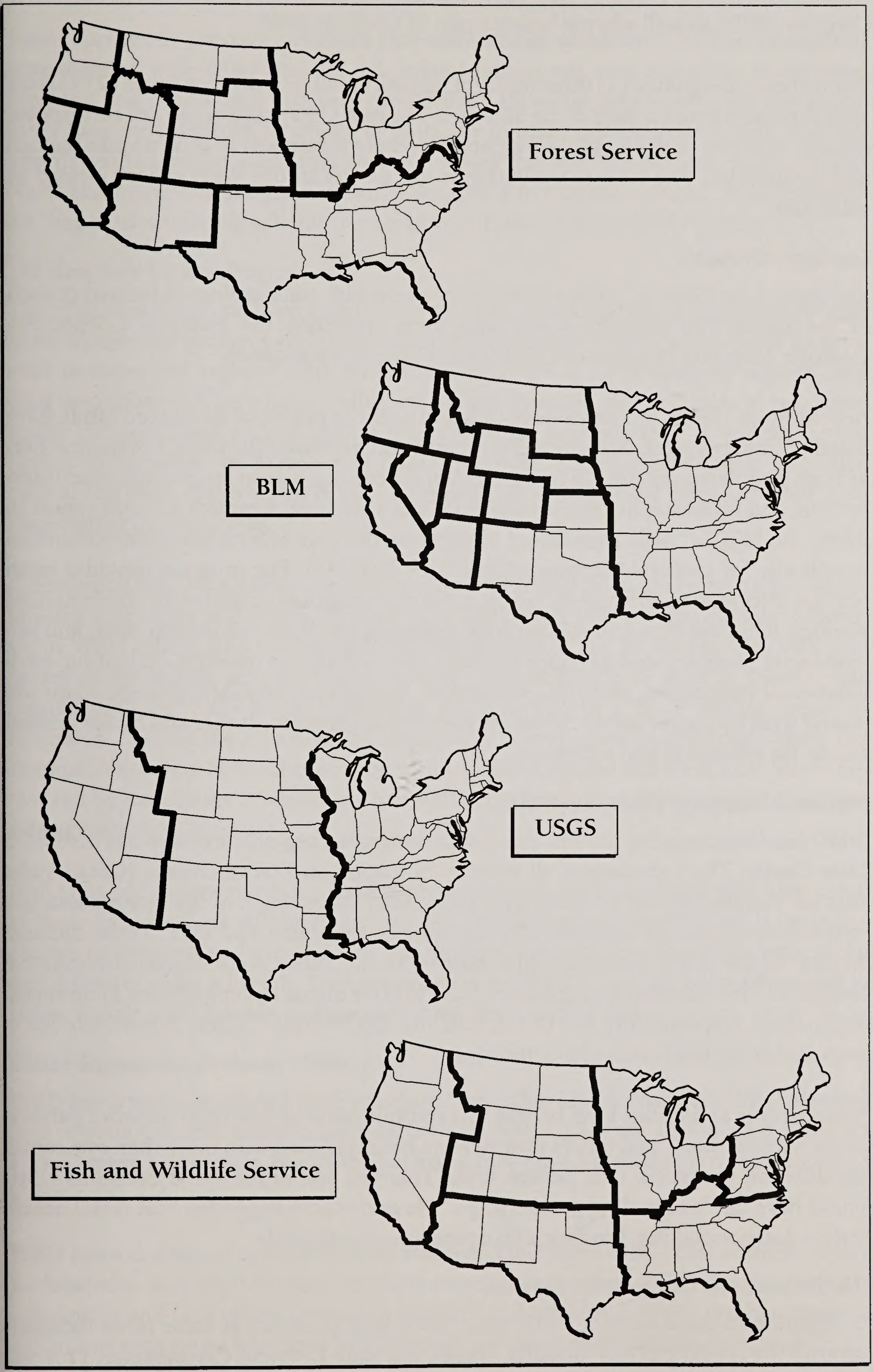
The agency originated and is participating in the transfer proposed by the Administration of aeronautical charting to DOT, but it is strongly resistant to having its geodesy and nautical charting programs moved to other departments because of their relevance to its mission and the larger missions of NOAA and the Department of Commerce.

FIELD-LEVEL COORDINATION AND COOPERATION, AND INTEGRATION OF GI FUNCTIONS

Capacity-sharing among federal agencies and with state and local governments for development of the NSDI requires a strong field presence and coordinated efforts among federal agencies. Unfortunately, current federal field office jurisdictional boundaries and locations differ from each other, and some do not conform to state boundaries, making the process of coordination difficult and complex. Figure 5-2 shows the differing regional boundaries of four federal agencies having GI activities and land management responsibilities.

A few agencies have established state coordinators for their programs, but there is no one charged with interacting with state, local, and tribal governments on a broad base of GI functions. Had the 10 standard federal regions of the 1970s survived, the problem might not be as complex, but the tendency in recent years has been for agencies to tailor their field structures to meet program needs and facilitate interaction with local, state, and regional counterparts.

FIGURE 5-2: DIFFERING REGIONAL BOUNDARIES OF FEDERAL AGENCIES HAVING GI ACTIVITIES AND LAND MANAGEMENT RESPONSIBILITIES



Geological Survey (USGS)

In recent years, USGS has moved toward greater consistency among the field structures for its divisions, namely the Geologic Division, the NMD, and the Water Resources Division (WRD). This effort has carried forth for the Biological Resources Division (BRD) as well when it became part of USGS in 1996.

The director designated (1) three uniform regions for all four divisions, and (2) a USGS state representative for each of the 50 states. The new USGS regions do not correspond directly with any of the divisions' regions, but there is an effort to synchronize regions and boundaries. The state representatives are mostly in the WRD offices located in each state.

Geologic Division

The staff of the Geologic Division work primarily with state geologists located in each of the states. The division works with them regarding the National Cooperative Geologic Mapping Program (NCGMP) established by legislation.

According to USGS, increases in population and the extent of developed lands have taxed natural resources and the environment and increased the impact of natural hazards on populated regions. In recognition of the resulting need for geologic map information, and following the recommendations of a National Research Council report in 1988, the NCGMP was established in 1992 as the sole federal program authorized specifically for geologic mapping (Public Law 102-285). The program provides earth science information for federal lands, constructs regional (multi-state and national) geologic data bases, coordinates geologic mapping activities with federal, state, and private-sector partners, and develops transferable methods for resource evaluation, environmental restoration, and risk assessment. In addition, NCGMP geologic maps are widely used by the private-sector as the basis for site-specific studies and by the general public for education and recreation.

National Mapping Division (NMD)

NMD has four mapping centers, three with designated regions, and also has the EROS Data Center. The four centers all have coordination and requirements (C&R) staffs that are responsible for working with designated states. Each of the centers also has national management responsibility for specific programs and data. These include: Reston VA for NAPP and geographic names; Menlo Park CA for digital orthophotos; Denver CO for elevation and graphics; Rolla MO for digital raster graphics. Denver and Rolla share responsibility for DLGs, and the EROS Data Center, Sioux Falls SD is responsible for land cover characteristics.

Some people at the state level believe this centralization of functions impedes partnerships because states and others now need to have relations with more than one center for different programs. One person said, "This was one of the worst decisions NMD could have made regarding partnerships." He and others suggested that NMD decentralize decisionmaking, funding, and operations significantly.

The Former State Cartographer Program

In addition to these centers, NMD once had a field presence in some other locations around the country. NMD formerly funded the State Resident Cartographer Program and had a few cartographers assigned to states, such as Idaho and Oregon. Each state situation was different; some had partial state financial support, and most were physically located in state, rather than federal offices. However, NMD eliminated the program in the early 1990s.

States apparently liked the program. One state official said it was "the best example of a partnership with states because this federal person was very accessible to the state, localities and others, and was very productive." However, this person did not necessarily have the resources, flexibility or authority to make necessary decisions, and success depended on the individual who performed this role. Project staff were told that NMD eliminated this program because, according to one state official, these individuals "began to sound and talk like a state person rather than an NMD person."

The New State Liaison Program

The NMD's strategic plan says that it will be "a more decentralized organization with more distributed program and operational responsibility." "NMD will expand its presence in states and regions" and "have representatives in most states or regions, and field operations will be a major influence on the direction and priorities of programs under the guidelines and principles established by headquarters." A specific action item is to "increase the presence of NMD employees in appropriate State locations, such as the state offices of the WRD, USGS regional offices or the offices of other state cooperating organizations."[19]

Accordingly, NMD is establishing state liaisons in various locations around the country to work with states and others. By the end of 1997, there will be eight of these liaisons, six in WRD offices, one for the State of Utah located at the Forest Service (who also serves as the liaison with the Forest Service), one as liaison to BLM in Denver, one located with the FWS in St. Petersburg FL, and one in a BRD science center in Louisiana. Most of these liaisons are expected to cover some neighboring states. For example, the one in Massachusetts covers all of New England and New York. States not covered by liaisons are covered by C&R staff in the mapping centers, so each state has a designated NMD contact.

NMD has not chosen to place a liaison person in each state, nor has it said how many of these liaisons there will be in future years. NMD headquarters has left it up to the centers to determine where there are appropriate opportunities and to propose when and where to place a liaison. This opportunity apparently has not been advertised to states, but no state that has requested one has been turned down.

Water Resources Division (WRD)

WRD has a more developed field structure than other USGS divisions. WRD also has four regions, but they differ in boundaries from NMD. They are also located in Menlo Park, Denver, and Reston, but instead of Rolla, they have a southeastern region located in Norcross, GA.

WRD has a district office located in all states and in Puerto Rico. Most of these offices are located in state capitol cities, but there are some exceptions. WRD also has multiple sub-district and field offices located in all states and territories. WRD also has research affiliations with states who have WRD-supported water resources research institutes.

Some WRD state offices have had extensive roles regarding GI and GIS in the states. Some of the first GIS activities in state governments, such as in Massachusetts and Wyoming, were established in affiliation with these WRD offices during the mid 1980s. Some of them continue to have very active roles and serve as the leading and coordinating federal GI or GIS contacts in certain states at their own initiative. For example, North Carolina's WRD office, which initiated the interagency federal GI group in the state, which is among the strongest state-based federal GI groups in the United States.

Biological Resources Division (BRD)

BRD has three regions, located in Denver, Seattle, and Leetown WV. It also has 16 science centers that report to the regional offices. In addition, BRD has two other field programs that it inherited from the FWS that are essentially organized by state. Similar to WRD's water resources institutes, BRD administers cooperative research units that are located at state universities. BRD also administers the Gap Analysis Program, which is a federally funded, state-by-state program using satellite data to characterize land

TABLE 5-1: FEDERAL AGENCY FIELD STRUCTURES AND THEIR COUNTERPARTS: GEODETIC AND GEOLOGICAL AGENCIES

Geographic Level	National Ocean Service	Geological Survey				
		Entire Agency	National Mapping Division	Water Resources Division	Geologic Division	Biological Resources Division
Multi-state Regional	N/A	3	4	4	3	3 16 Science Centers
State	22 State Geodetic Advisors[1]	State WRD Offices	8 Liaisons[2]	About 50 State/ District Offices *About 50 Research Institutes*[3] *50 State Engineers*	50 State Geologists	About 50 Coop Units[4] *About 40 GAP Affiliates*
Sub-state				261 Subdistrict/ Field Offices		

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[1] Jointly funded by State, most housed in State DOT.

[2] Now cover more than one state; formerly had some joint Federal/State-funded State Cartographers.

[3] Located at state universities.

[4] Located at state universities.

Italics represent nonfederal government offices.

resources for habitat protection. About 40 states have active GAP activities. They are primarily located at cooperative units in state-supported universities, but some are located in state agencies. Additionally, 10–12 states have a state biological survey-equivalent that works directly with BRD, similar to the state geologists with the rest of the USGS.

Table 5-1 shows the federal agency field structures and their state and local counterparts for both USGS and NOS.

Bureau of Land Management (BLM)

BLM has 11 state offices to cover 14 western states, plus the eastern states office in Springfield, VA, which covers the remaining 36 states. The boundaries of these offices correspond to those of their states, except the Oregon office, which includes Washington, and the Montana office. The Montana office includes North Dakota and South Dakota. Those outside BLM find this structure easier to work with than other schemes, in contrast with that of the Forest Service. The state offices are subdivided into districts which correspond in size generally to national forests in the Forest Service.

Forest Service

The largest agency in the USDA, the Forest Service's National Forest System (NFS) has nine regions, the Geometronics Service Center, 155 forests, and approximately 128 forest supervisors with 600 districts, as well as grasslands and other areas. Two other parts of the agency have field structures. The Research Program has eight experiment stations, the Forest Products Laboratory in Madison, WI, and forest science laboratories in 74 locations. State and Private Forestry's (S&PF) field offices are collocated with NFS regions, except in the northeast region where the NFS office is in Milwaukee, and the S&PF office is in Radnor PA.

Some of the regional boundaries utilize state boundaries, but in a few cases the boundaries of the regional offices do not coincide with state boundaries. Idaho and Wyoming are split between two and three Forest Service regional offices, respectively. Each forest traditionally has had its own management on site, except that some states in the southeast have a unique structure. There are single offices responsible for all forests in a number of states, including Florida and North Carolina. This approach has worked well over the years in working with state and other agencies in many respects. It has been particularly helpful from an information perspective. (The Forest Service noted that such states have limited acreage compared with California, Idaho, and Montana. The western regions manage vast areas of land which is not conducive to the eastern regions' single points of contact.)

During the 1990s there have been several efforts to consolidate regions, forests, and districts, but congressional approval is required to change these official boundaries. Some district offices have been closed and consolidated, but these actions are often protested by local communities. Some forests are under shared management, such as the Humboldt and Toyaibe in Nevada. In Utah, there are efforts to coordinate the six forests into a northern area and a southern area, particularly regarding land management planning. These efforts seem to help in working with the state and other organizations. There is also some "zoning" of certain professional skills, so that, for example, a surveyor is shared by two forests. Consideration also is being given to zoning skills between regions, particularly in the mountain states.

Over time, various regional offices have attempted to communicate and partner with states in their regions. In states such as Florida, North Carolina, and Nevada, it is clear which offices are appropriate contacts for states and others, and relationships develop accordingly. However, project staff were informed that relations between the Forest Service and other states are more problematic (even those with regional offices inside them) because it is not clear which office to work with, when, or about what. It is generally easier to work with the forests that have a more common mission with states than with regional offices. Regional offices can impede partnerships because they are too distant from the data and the on-the-ground activities. (The Forest service noted that regional offices are not intended to be involved in on-the-ground field activities occurring at the forest level. Often times the regional office staff function as a point of contact for similar programs occurring at the state or other agency level.)

TABLE 5-2: FEDERAL AGENCY FIELD STRUCTURES AND THEIR COUNTERPARTS — FEDERAL LAND MANAGEMENT AGENCIES

Geographic Level	**Related State/Local Offices**	**BLM**	**FS**	**F&WS**	**NPS**
Multi-state Regional		Eastern States Office (36 States) Montana, North and South Dakota Oregon and Washington	9	7	Reorganizing
State	*50+ Land Management Agencies* *About 40 GI/GIS Coordinators* *<10 Cartographers* *<10 Surveyors*	12 State Offices	6 with Single Office for All Forests *50 State Forestry Organizations*	*50 State Fish and Wildlife Agencies*	*50 State Park Agencies*
Sub-state	*3403+ Land Recordation Offices* *About 1000 County Surveyors*	59 Districts 140 Resource Offices	156 Forests 600+ Districts *Urban Forestry Offices*		374 Individual Parks and Local Units *Local Park Agencies*

Italics represent nonfederal government offices.

Recently, the Forest Service has increased efforts to work better with states, including the divided ones such as Wyoming. A data-sharing agreement is under development between the state and the Forest Service that is similar to one signed with BLM.

Table 5-2 shows the federal land management agency field structures and their state and local counterparts.

NOAA's National Ocean Service (NOS)

Given the mission of the agency, NOS's activities are focused on the coasts, ports, and water. NOS does not have regions, but its offices are located in shipping centers, including Norfolk and Seattle. The new Coastal Services Center (CSC) is located in Charleston SC, and NOS has a small presence in Seattle and Juneau AK. CSC works nationally, but each CSC project has a state, regional, or local partner. The San Francisco Bay Project under CSC was initiated to support navigation and coastal resource management and protection, and it may be a role model for other shipping centers in the country. NOS also manages 12 marine sanctuaries, 23 national estuarine research reserves, and has partnership arrangements with about 30 coastal states under the Coastal Zone Management Act. Further, NOAA manages the nation's fisheries through regional fishery management councils.

NGS has established a field structure through the State Geodetic Advisor program. Operational since 1974 and well-regarded in the states, the purpose of the program is to provide liaison between NOS and host states, with a jointly funded NOS employee residing in such states to guide and assist the state's charting, geodetic, and surveying programs. The program is designed to fill a need for more accurate geodetic surveys, and is in response to states' desire to improve their surveying techniques to meet federal geodetic standards. It also provides support for state surveying efforts available through the Federal Aid Highway Program. The primary service provided by the advisor is technical expertise since the trend is for NGS to do less field data collection.

Increasingly, the technology is being transferred, with NOS guidance and assistance, to states where either state personnel or contractors actually collect the geodetic data. The advisor educates and trains state personnel, assists the state in planning and coordinating geodetic surveys, provides quality assurance, and suggests mark maintenance activities. The advisor also trains and assists state personnel in the preparation of survey data in a format compatible with FGDC standards. Currently 22 states have an advisor (Massachusetts and New Hampshire split the cost of one advisor, hence 21 staff) with these states contributing approximately $40,000 each to support salaries. Most states also provide some administrative support for housing the advisor within a state agency, usually in the state department of transportation, and one in a natural resources agency. Some are located in NOAA offices.

The state geodetic advisor program is often complemented by state officials, and it has been put forth as a role model for other agencies.

Other Agencies

NRCS in USDA is worth mentioning because of the agency's extensive presence at the county level. NRCS has six regions, located in Beltsville, MD; Lincoln, NE; Atlanta, GA;

Fort Worth, TX; Madison, WI; and Sacramento, CA. Fort Worth has two national centers, including cartography and spatial data, and employee development. Fort Collins, CO is the national technical center. The role of the regions was formerly to provide contact with states and others, and to provide technical support. It was decided a few years ago to transfer this role and staffing to NRCS state offices so as to better work with other federal agencies and the states. The role of the regional offices is now to conduct spatial analysis, planning and program support, while outreach is through the state and other offices.

NRCS has an office in each of the 50 states and in about 2,500 of the 3,043 counties in the United States. The role of the state offices is to conduct outreach and partnering. Each state office has a designated GI coordinator, who might also have other roles but serves as an overall higher level contact for others. In addition, most states have a full-time GIS specialist who can work with others in a technical capacity. NRCS's goal is for all states to have a specialist.

Other federal agencies are engaged in program-related GI activities in cooperation with state counterparts and others. The DOT's Federal Highway Administration has division offices in the states that work with their counterparts in state DOTs. FEMA has 10 regional offices which interact with state emergency management agencies, and it has four mobile GIS units which can be deployed for disaster response.

EPA also has ten regional offices which work directly with their counterpart state environmental agencies and fund some GI activities. HUD's field offices are located in ten regions as well, and they have worked with state counterparts to build GI capacity in urban areas. The field offices recently have been building this capacity locally as the roles of regional offices have diminished.

TABLE 5-3: FEDERAL AGENCY FIELD STRUCTURES AND THEIR COUNTERPARTS — OTHER FEDERAL AGENCIES

Geographic Level	NRCS	EPA	Census	FEMA	FHWA	HUD
Multi-state Regional	6	10	12	10	9	10[1]
State	50 State Offices	*50 State EPA Equivalents*	*50 State Data Centers*	*50 State EMAs*	50 State Division Offices *50 State DOTs*	50 State Offices 50 State Housing and Community Development Organizations
Sub-state	*About 2500 County Offices*	*Local Environmental Organizations*	*State Data Center Affiliates*	*Local Emergency Management Coordinators*	*340 MPOs* *Local Highway/ Transportation Departments*	26 Area Offices

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[1] Regions replaced with Areas.

Italics represent nonfederal government offices.

TABLE 5-4: FEDERAL FIELD PRESENCE IN STATES

State	Geological Survey			NOS	BLM	FS	F&WS
	NMD	WRD	BRD				
Alabama		S				S	
Alaska	S	S	O		S	R	S
Arizona		S			S		
Arkansas		S					
California	R	R	O	S	S	R	R
Colorado	R	R	R,O	S	S	R	R
Connecticut		S					
Delaware		O		S			
Florida	S	S	O	S		S	
Georgia		R				R	R
Hawaii		S	O				
Idaho		S		S			
Illinois		S	S				
Indiana		S					
Iowa		S					
Kansas		S	S				
Kentucky	S	S					
Louisiana		S	O	S			
Maine		S	O				
Maryland		S		S			
Massachusetts	S	S		S			R
Michigan		S	O	S			
Minnesota	S	S		S			R
Mississippi		S		S		S	
Missouri	R	S	O				
Montana		S		S	R	R	
Nebraska		S		S			
Nevada		S			S	S	
New Hampshire		S		S			
New Jersey		S		S			
New Mexico		S		S	S	R	R
New York		S					
North Carolina		S					
North Dakota		S	O			S	
Ohio		S		S			
Oklahoma		S					
Oregon	S	S	O	S	R	R	R
Pennsylvania		S					
Rhode Island		O					
South Carolina		S		R			
South Dakota		S					
Tennessee		S					
Texas	S	S				S	
Utah	S	S			S	R	
Vermont		S		S			
Virginia	R	R			R		
Washington		S	R,O	S			
West Virginia		S	R,O				
Wisconsin		S	O	S		R	
Wyoming		S			S		

S = State-based Office   R = Regional Office   O = Other Office

In an enterprise as vast and diverse as the federal government, it is not surprising that federal agencies have differing regional boundaries and that some are incongruent with state boundaries. However, such complexity makes it difficult for various levels of government to work together on GI activities and for federal agencies to coordinate their own activities with each other. In addition, the boundaries of federal field offices are dictated largely by program needs and not by support services, such as those for GI and GIS. Even where GI is part of the efforts to fulfill program missions, it is still subordinate to other activities. All of this makes it challenging to conform federal field boundaries and practices to meet GI needs, but steps can and should be taken wherever possible to facilitate interactions.

Table 5-3 shows the field structures for other federal agencies and their state and local counterparts.

The MSC recommended that state-based focal points be established within the federal government to coordinate data production and partnerships, including regional coordination staff and coordinating positions within agencies.[20] Table 5-4 provides a state-by-state summary of the federal field presence for seven natural resource agencies.

Proposal to Establish Federal Focal Point for GI in Each State

A proposed "spatial data sharing program" recommended by the MSC in 1993[21] included the designation of federal spatial data advisors for all of the states. These advisors would be federal employees similar to NOS's state geodetic advisors. The state-level advisors would determine what base data being collected within their states are candidates for incorporation into federal data sets. The advisors would work with the applicable federal agency responsible for the appropriate FGDC framework or thematic layer and help to determine whether a given data set might be included in the federal data set. If agreed, a plan would be developed for incorporating the state data and for providing partial reimbursement of costs for the collecting such data.

FILLING OUT THE FGDC FRAMEWORK LAYERS

The 1994 executive order required the FGDC to submit a plan and schedule to OMB within nine months of the order's issue date for completing the initial implementation of a national digital geospatial framework by January 2000 and for establishing a process of ongoing data maintenance.[22] In April 1995, the FGDC submitted the required report which had been prepared by representatives of local, regional, state, and federal agencies under its auspices. Among other things, the report said: "Innovative institutional arrangements are needed to ensure a robust and well-maintained framework. Ideally, the framework data for a geographic area will be developed, maintained, and integrated by organizations that produce and use data for that area."[23] Six institutional roles for framework were proposed:

- policy establishment – to provide overall guidance for the framework
- theme expertise – to guide the development of the framework to meet new trends and needs in the user community
- area integration – to incorporate contributions of data into the framework for a geographic area

- data production – to generate data used to build and maintain the framework
- data distribution – to provide framework data to users.

For framework management, that is, providing nationwide, continuing operational support to the framework, the report said a consortium of organizations knowledgeable about the themes and having national responsibilities was needed and suggested that federal agencies assigned by OMB to lead data efforts could play this role. Both framework subcommittees and lead agencies have been assigned for every framework layer (see Table 5-5), and theme leaders are developing five-year plans which were to be available in October 1997.

For area integration, the report said "certified area integrators" could incorporate the contributions of data producers into the framework.[24] Areas of responsibility could cover different units of geography, such as a state or group of states. The framework managers would be the "default integrators" for areas not having an integrator. No such integrators have been designated but grants have been awarded to groups in North Carolina and Utah to begin integrating data from federal, state, and local sources into statewide data sets for the cadastral layer. Data are to be made available through an NSDI clearinghouse.

Finally, the report discussed the need to begin establishing the necessary organizational relationships and agreements for framework operations; and for prototype arrangements needed for framework operations, especially those of area managers; and the need to raise awareness of the framework within organizations whose participation is needed. So far, FGDC's attention has been focused primarily at the national level. An agreement is in place among Census, EPA, and USGS to develop data for three framework layers for use in the 2000 census. USGS is also holding workshops with state and local government representatives on topics such as converting data from high resolution to lower resolution and determining what is needed to get local governments started in developing GIS, but no area integrators have been designated. One FGDC official told project staff that he understands the need to "go national," but it is difficult to get consensus and execution. Regional approaches are being explored.

TABLE 5-5: FRAMEWORK LAYERS AND ASSIGNMENTS

Framework Layer	Responsible Agency	FGDC Subcommittee
Geodetic	NOS/NGS	Geodetic Science
Orthoimagery	USGS/NMD	Base Cartographic
Elevation and Bathymetry	USGS/NMD and NOS	Base Cartographic and Bathymetric
Hydrography	USGS/NMD and NOS	Water and Bathymetric
Transportation	DOT/BTS*	Ground Transportation
Governmental Units	Census	Cultural and Demographic
Cadastral	BLM	Cadastral

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*The Bureau of Census and USGS are working closely with DOT's Bureau of Transportation Statistics.

The Panel believes the framework developed by the FGDC is a fundamentally sound approach to building the underlying content for the NSDI. Promising first steps have been taken to meet the goal of populating all framework layers by the year 2000. The Panel also supports the designation of specific agencies as managers of the themes. It is concerned, however, that the institutional arrangements described in the 1995 report, including the area integrators, are not in place and there are no apparent plans or initiatives, other than the proof-of-concept grants, to move beyond what are basically top-down, federal government management and implementation. It is also concerned about the differences in the frameworks being pursued by FGDC and NIMA, each to meet the needs of their respective sectors. There are legitimate reasons for the differences, but as more and more data sets developed by NIMA become available to the civil community, worldwide, there is a risk that FGDC's framework might not take hold outside a very limited community of civil agencies and a few others in the GI community. This provides all the more reason for NIMA to become more active in FGDC and cooperate more closely with its civil-agency counterparts in framework development and implementation.

BASE VERSUS PROGRAM-RELATED GI

In examining opportunities for consolidating federal GI programs and agencies, it became increasingly clear that a distinction could be made between agencies whose mission is to produce spatial data for others versus agencies that produce or procure spatial data for their own program needs. Agencies or units like NOS's NGS and Office of Coast Survey and USGS's NMD, which largely produce data for others, are more likely candidates for consolidation than, say, FEMA, or even its Mitigation Division or Flood Insurance Administration, which produce or underwrite spatial data used by others but needed primarily for program purposes, and which have programmatic ties to the field of emergency management and other components, such as emergency preparedness and response. Somewhere in between is the Geography Division in the Census Bureau, which maintains TIGER, the Topologically Integrated Geographic Encoding and Referencing system, a commonly used national database of road centerlines.

A distinction can also be drawn between agencies, or distinct parts of agencies, whose primary missions are to produce spatial data versus those with spatial data functions that are secondary to their program missions. Thus, NRCS in the USDA and ACE in DoD have extensive GI activities but they are secondary to their resource conservation and flood control, and construction functions, respectively.

BASE GEOGRAPHIC FUNCTIONS AND THE CASE FOR A NEW GEOGRAPHIC DATA SERVICE*

GI functions performed by federal civil agencies have evolved over long periods of time, and their present locations are as much an accident of history as they are a logical choice to meet today's and tomorrow's needs. For example, geodetic referencing emerged as part of the Coast and Geodetic Survey because of its affiliation with requirements for nautical charting, even though geodesy relates more to the land mass and precise positioning on land than to coastal or ocean navigation. Similarly, aeronautical charting evolved in the same organization because of its charting expertise, not its affiliation in any way with aeronautics.

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* The Panel considered the naming the new organization the Geographical Information Service, but it was concerned its initials, GIS, would be confused with "GI system."

The goals and strategies of the agencies heavily engaged in GI are still dictated primarily by their program requirements, not creation and maintenance of consistent and integrated base geographic data or an NSDI. With constraints on funding at all levels of government, agencies must meet their own needs first and respond to the needs of others only if funding is available or they are mandated to do so. Many officials interviewed by the staff see the value of an NSDI and data sharing, but they lack the funds to comply with metadata and other requirements, and they are focused on meeting their own customers' needs.

Federal agencies' structures and organizations, combined with the U.S. federal form of intergovernmental structure, inherently are not well-suited to building or promoting integrated national geographic data sets. The staff's research and interviews revealed better cooperation among the agencies but little diminution in the overlap and duplication among agencies and levels of government that served as the basis for the consolidation recommendations of past studies. There is greater awareness of the need to coordinate and share data, but program imperatives and specialized data needs still drive agencies at all levels of government to acquire data with formats and content suited to their own requirements and largely without regard to the needs of others.

The current federal structures and practices for GI need not be massively transformed as was recommended in 1973 and 1981, in part because of evolving technology and growing interagency cooperation, but the Panel believes that consolidation of base GI functions could improve efficiency and provide a stronger platform for building the NSDI.

The Case for a New Geographic Data Service (GDS)

Efforts to consolidate federal GI functions have not been successful, notwithstanding repeated recommendations to do so. Across government, it has become increasingly difficult in the past two or three decades to restructure major federal functions, especially when such functions span the jurisdiction on several authorizing committees of Congress. Whereas the President once had authority to send Congress reorganization plans subject to up-or-down votes within specified time periods, he now has no authority to modify the structures of organizations established by law. The administration has shown no interest in reorganizing these functions, and no major consolidation of GI functions could be done without a change in law.

Initially, reorganizations generally save little or no money, and they are often costly to productivity and operational efficiency. At the same time, there have been no major changes for decades in the structures for creating and producing base GI to meet the federal government's and the nation's needs. There do appear to be synergies among geodesy, topographic mapping, surveying, and possibly nautical charting that could be more effectively exploited through consolidation of at least some of the functions now being performed separately. In short, a point on the earth is a point on the earth, no matter how it is measured or for what purpose. A plan could be fashioned to bring about such consolidation over time in ways that would not result in wrenching change or significantly increased costs.

New cost savings are attainable by combining staffs at headquarters and the field, taking greater advantage of data produced by other levels of government and the private sector, use of common support services, and better integration and use of technology. However, the Panel did not attempt any benefit/cost analysis because of major unknowns about the NSDI concept listed in Chapter Two and uncertainties about any new organization before the basic concepts behind it are more thoroughly analyzed and tested in the field.

The potential cost savings are not the only – or even primary – reason the Panel believes a new GDS should be created. If creating a robust NSDI and achieving much greater spatial data-sharing across agency boundaries, political jurisdictions, and with the public and private sectors are the goals, then the Panel believes it is essential to achieve "critical mass" by bringing together most of the fundamental components that are responsible for the basic GI functions of the federal government. These goals are enormously ambitious, and efforts to achieve them require a strong mandate and solid support. Good intentions, consensus, and technology alone will not fulfill these goals, only provide the base for promising but modest first steps. The new GDS, along with a legislatively mandated policy base, an NSDC, an FGDC refocused on federal GI activities, and stronger partnerships with key state/local and private-sector participants are all necessary to meet the goals.

Although some functions would be merged within a single organization, the Panel's intent is not to "centralize" but to provide a stronger base from which certain federal GI functions can be further decentralized at the field level and brought into closer harmony with the structures and practices of other sectors. The Panel is also sensitive to the individual agencies' operating responsibilities and is proposing a phased implementation of the GDS with the expectation that potential operating problems during the transition be taken into account in both the design and implementation of GDS.

Possible Model for the Geospatial Data Service's Mission and Structure

There are several possible approaches to creating a GDS and defining its scope. Below, the Panel presents one possible approach, mentioning alternatives where appropriate.

The GDS could be established as an independent entity within DOI, reporting to the secretary. The Panel chose the name "service," rather than the more traditional "bureau" to denote its role as providing essential services to federal agencies, other sectors in government and the private sector, and to the American public.

Mission and Goals

The mission of this new organization under this approach would encompass that of all the agencies transferred into it, but the whole should literally be more than the sum of its parts. Therefore its mission would be to:

> Support the full development of the NSDI, and ensure that U.S. economic, governmental, and societal needs for GI and services are met in cooperation with all levels of government and the private sector.

GDS would adopt the goals of its components (noted in parenthases), including:

- improving land, resource, and title information (BLM)
- ensuring the production and availability of basic cartographic and spatial data of the country (USGS)

- coordinating national spatial data policy and standards (USGS)
- improving the understanding and application of geospatial data and technology (USGS)
- renovating the existing coordinate reference system to provide the higher accessibility and accuracy available from the GPS (NOS)
- building, maintaining, and delivering a digital nautical charting database to underpin new electronic navigation systems which integrate satellite positioning, tidal heights and currents, radars and sonars, and navigational aids (NOS)
- producing base maps and derived map products, feature data (Cartographic Feature Files), elevation data (Digital Elevation Models), image data (Digital Orthophoto Quads), and metadata.
- providing training and technical assistance and a clearinghouse for federal geospatial products.

GDS also could adopt the goals specified for the NSDI and fulfill the vision of making current and accurate geospatial data readily available to contribute locally, nationally, and globally to economic growth, environmental quality and stability, and social progress.

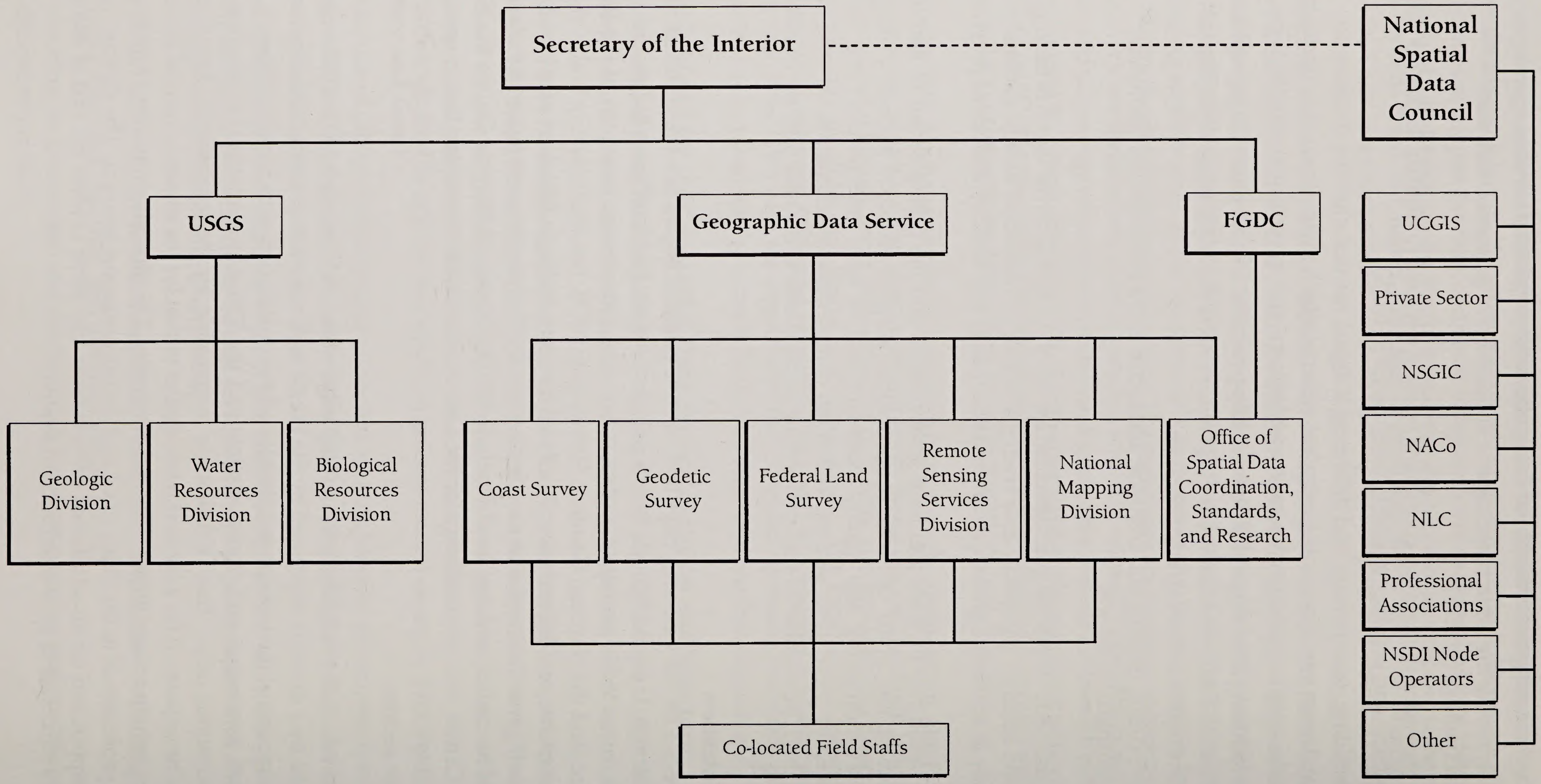
GDS would rely on state and local governments and the private sector to the extent practicable and phase out federal operations (keeping on board necessary skills for contract monitoring and quality assurance and to meet emergencies) that can be assumed by these other sectors. The initial complement of federal staff should be no more than the number of staff performing its functions at the time they are transferred to GDS.

Organization

Figure 5-3 on the following page lays out one possible organizational structure of the new service. It would include BLM's cadastral survey and land records functions, the NMD from USGS, surveyors and possibly the geometronics functions of the Forest Service, and the National Geodetic Survey from NOS. Nautical charting is also shown as part of this new organization. The Panel favors including it, but there may be reasons for leaving it in Commerce or transferring it to DOT. A remote-sensing services division would be created and that would include NMD's Advanced Systems Center, the EROS Data Center, and responsibility for the Civil Applications Committee. Its job would be to facilitate civil access to remote-sensing products and services of both the public and private sectors.

To provide independence, professional leadership, and continuity, the GDS could be headed by a director appointed by the President from a list of candidates supplied by the secretary of the interior and developed in consultation with the secretaries of agriculture, commerce, and transportation; and the EPA administrator (i.e., the heads of organizations other than DOI that are responsible for the framework). The director could be appointed for a six-year term, similar to that for the commissioner of labor statistics, to help ensure impartiality and continuity. The director should be a highly qualified professional in the fields of GI and decision-support sciences. The director could be reappointed for an additional six-year term and serve beyond the end of any term until a successor is appointed and confirmed.

FIGURE 5-3: GEOGRAPHIC DATA SERVICE AND NATIONAL SPATIAL DATA COUNCIL


Secretary of the Interior
National Spatial Data Council
USGS
Geographic Data Service
FGDC
UCGIS
Private Sector
NSGIC
NACo
NLC
Professional Associations
NSDI Node Operators
Other
Geologic Division
Water Resources Division
Biological Resources Division
Coast Survey
Geodetic Survey
Federal Land Survey
Remote Sensing Services Division
National Mapping Division
Office of Spatial Data Coordination, Standards, and Research
Co-located Field Staffs

The GDS also could have an Office of Spatial Data Coordination, Standards, and Research which would:

- have overall responsibility for federal NSDI strategy
- serve as the secretariat of the FGDC and as liaison to the NSDC
- perform a wide array of additional functions, including the monitoring of federal spending for GI (including that in federal-aid programs) for data acquisition and maintenance, as well as for research and development; and surveying similar expenditures by state, local, and tribal governments
- prepare a special analysis for the President's budget
- advise OMB on GI investments and spending by means of the Results Act cross-cutting analysis discussed in Chapter Four
- administer the CCAP and other grant programs designed to build state, local, and tribal GI capacities and common data sets.

Each of GDS's divisions could be made responsible for a significant segment of NSDI. In addition, the NMD would house the government's principal GI production facilities and provide training and technical assistance and spatial data services to other federal agencies to the extent possible on a reimbursable basis. This would help agencies develop "user-friendly" GIS, thereby converting these agencies from data producers to users.

The service's new field structure could be place-based, that is, regionally rather than jurisdictionally focused. It could link more directly with state GI coordinating groups and to local and tribal government GIS capabilities in those states. State liaisons could be made responsible for coordinating with federal program officials having GI-related responsibilities.

One approach would be to establish about 20-25 GI centers, each of which would be responsible for a variety of GDS programs. In this way, each could ensure that the different data efforts correspond to each other, both in terms of data accuracy and programmatically. In this way the centers could be more effective partners in the effort to leverage money and plans with other federal agencies, states, localities, and private entities. These offices and their staffs would need the authority and resources to partner with other federal agencies, the states, and others to generate and maintain spatial data, thus providing more flexibility in meeting national mapping requirements. GDS staff would need to be trained in, and acclimated to, working in a more flexible environment where others would be full partners in meeting common spatial data needs.

Specific Programs and Agencies for Transfer into GDS

Geodesy

The head of NGS has stated that the development of a consistent national coordinate system and support for the user community are two key parts of his agency's mission as it transitions to the NSRS relying on GPS technology. Maintaining a national grid of geodetic reference points is among the most fundamental of governmental functions, and it affects all other base GI functions. The Panel believes NGS would benefit by

TABLE 5-6: GEODETIC DATUMS USED IN THE UNITED STATES

North American Datum 1927 (NAD27)	World Geodetic System 1984 (WGS84)	North American Datum 1983 (NAD83)	Global Positioning System (GPS)
Established from observations in the United States Based on Clarke 1866 ellipsoid. Origin **not** at center of mass. Used for most civil mapping in U.S. by other agencies.	Established from observations over entire globe. Based on WGS84 ellipsoid. Origin **is** at center of mass. Used by DMA and other military mapping agencies.	Based on GRS80 ellipsoid. USGS maps are being converted to NAD83. Differences between WGS84and NAD83 are too small to affect maps at scales smaller than 1:5,000.	GPS satellite orbits and positions are established in WGS84.

Source: Frederick J. Doyle, "Map conversion and the UTM Grid," *Photogrammetric Engineering and Remote Sensing* (Volume LXIII, Number 4, April 1997), p. 367.

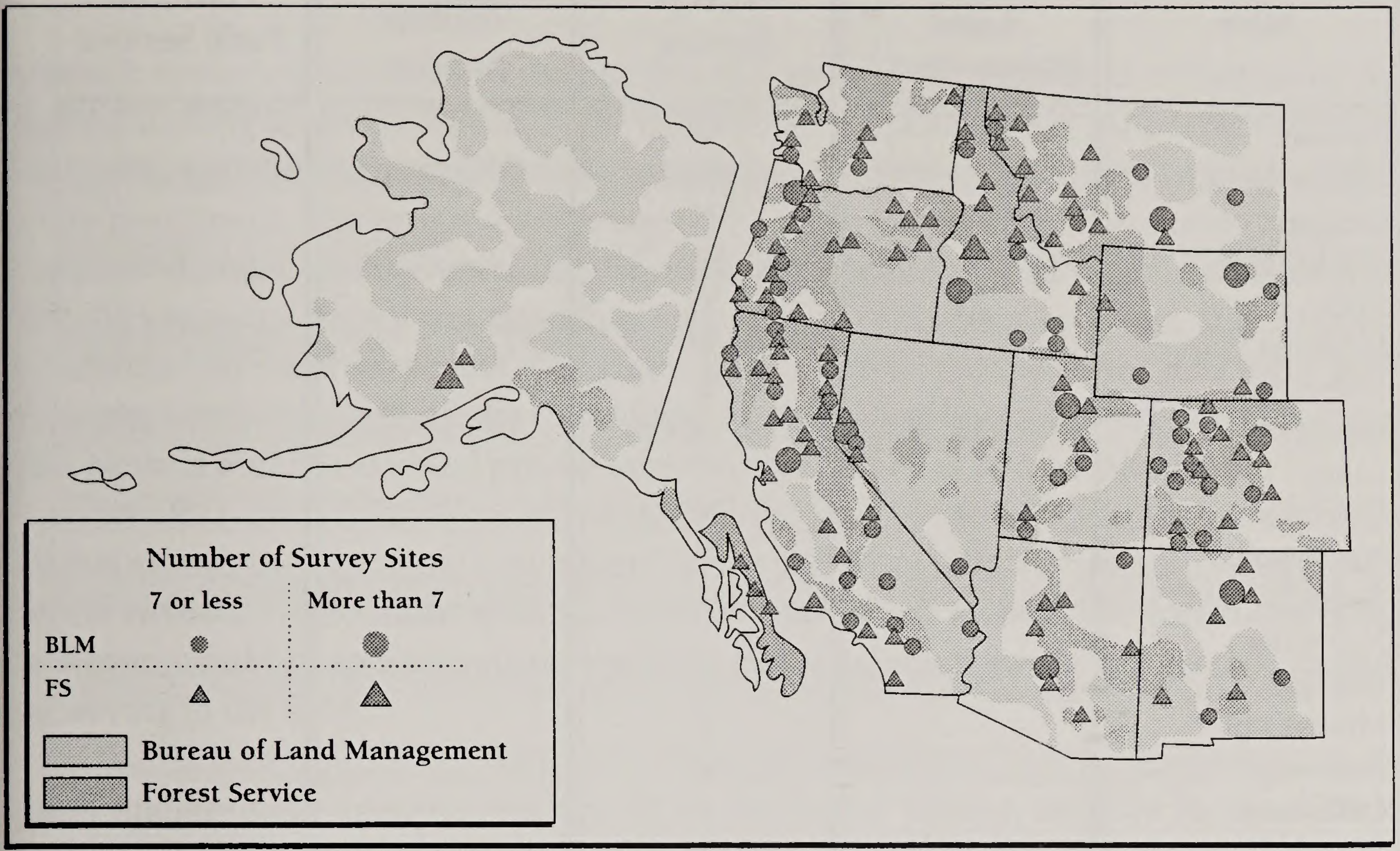
being affiliated with these other functions and by being housed in an agency with the mission outlined above for the GDS. Funding for this mission would not compete with other, less related programs in the NOS and Department of Commerce, and the GDS leadership should have a full understanding and appreciation for the fundamental role of geodesy in maintaining the nation's spatial data base. There would be competition with other DOI programs, to be sure, but geodesy's affiliation with other GI functions and, more directly, with the broad goals of NSDI development could help sustain its funding requests. Such requests also likely would go to the Interior and Related Agencies Appropriations Subcommittees which have shown stronger interest in GI functions in recent years than other subcommittees.

NGS has made progress in creating a common spatial referencing system, but there are still numerous geodetic datums (see Table 5-6) in actual use in the different GI functions across the country.[25] Moreover, the referencing of cadastral surveys are not tied directly to NGS's system, nor are some of the base cartographic maps being produced by USGS. The Panel believes that creating a common referencing system can best be accomplished in close affiliation with other base GI functions and that NGS should be transferred to USGS now. The specific location of NGS could be either within NMD or as a separate unit reporting to the director of USGS.

Surveying and Land Records

The cadastral survey and land records responsibilities of BLM and related responsibilities of other federal land management agencies are of a different character but no less relevant to the NSDI than the other base geographic functions, and they also could be assumed by the GDS. The Panel believes there is an opportunity for federal surveying to be performed more efficiently and at lower cost if this BLM function, as well as most of the surveying staffs of several agencies, were consolidated and placed on a more businesslike footing. The other key ingredient would be reliance on the private sector

FIGURE 5-4: COMPOSITE OF BLM AND FS LANDS IN TWELVE WESTERN STATES



Source: Bureau of Land Management.

where such services meet program requirements and could be procured at or below the cost of provision by GDS staff.

Federal surveyors are spread throughout several federal agencies and states as shown in Figure 5-4. Table 5-7 on the following page shows the number of surveyors in each of the four major land management agencies and their geographic location. The map for the western United States that follows shows the physical proximity of surveyors in the Forest Service and BLM. Consolidation of these small staffs in many locations could result in better service from the same number of employees or the same level of service with fewer employees. It also would provide better opportunity to coordinate the work of both organizations.

These survey functions could also benefit from a closer association with the NMD and NGS. There should be opportunities to combine some NGS and cadastral survey functions and to make full use of GPS and other technologies. (BLM Cadastral advised that it is technologically sophisticated and takes advantage of GPS. With the advent of GPS technology, all BLM surveys are now controlled by longitude and latitude.) In turn, BLM's state office network and close relations with many state surveyors could benefit other agencies that become part of the GDS. The new agency's survey operation could become a leader in its profession and an advocate for land law reform that would allow federal agencies, state, and local governments, and the public to take full advantage of the efficiencies in boundary location and land recordation permitted by new technologies such as GPS.

TABLE 5-7: SURVEYORS IN FOUR FEDERAL AGENCIES

State	Bureau of Land Management	Forest Service*	Fish and Wildlife Service	National Park Service
Arizona	26	9		
California	28	43	1	
Oregon	39	27		
Washington	2	15		
Idaho	29	25		
Montana	17	30		
Wyoming	17	3		
Nevada	13	1		
Utah	13	6		
Colorado	31	16	1	9
New Mexico	19	8		
South Dakota	1	5		
Nebraska		1		
Georgia		3		
Mississippi		2		
Alabama		2		
Louisiana		1		
Florida	2	1		
Virginia	7	3		
Tennessee		3		
Kentucky		1		
Arkansas	5	5		
North Carolina		4		
Texas		1		
New Hampshire		1		
Wisconsin	1	7		
Minnesota	1	7		
Michigan	1	7		
Vermont		4		
Pennsylvania		1		
Missouri	9	4		
Ohio		1		
Massachusetts			1	
Alaska	54	4	1	
West Virginia				2
Oklahoma	1			
Totals	**316**	**253**	**6**	**11**

Source: Bureau of Land Management.

* Later data provided by the Forest Service indicated that there are about 154 land surveyors in the Forest Service and another 71 surveying technicians and other disciplines.

In order to better assure that agencies whose surveyors are transferred into GDS get the same or better service than they have now, the cadastral survey operation could be done on a full cost-reimbursable basis, and agencies could be free to acquire service from the private sector if their needs are not met promptly by GDS surveyors. Consideration should be given to creating within GDS a performance-based organization* which would have additional flexibility in personnel and procurement and a multi-year set of performance expectations. Any PBO should have the flexibility to hire or contract for staff when its own staff is insufficient to meet customer demand.

Initially, surveying would form the nucleus of activity for the first three to five years. As federal staffing levels decline and surveyors retire (approximately 50 percent of BLM surveyors are eligible to retire within the next five years), training others would become more prominent. The progression from survey work to enabling others to do it is consistent with outsourcing trends and the original intent of the PLSS which called for federal surveyors to survey the township and section perimeters and have the sections subdivided by local surveyors. (Upgrading the skills of private-sector and local government surveyors through the "modulized" courses has been successful in Colorado and Nevada and has enabled private surveyors to survey to federal standards.)

In this model, the PBO would be housed in the GDS, but it could be a stand-alone unit in the Interior Department until the GDS is established by law. The long-term goal, however, would be to attain closer working relationships between the geodesists and surveyors in the field.

Land management agencies, such as BLM, the Forest Service, and the National Park Service would maintain limited core survey staffs to provide competency to meet urgent needs and oversee contracts with commercial surveyors.

For land title records, a decision would have to be made as to whether responsibility for ALMRS should be transferred to the PBO. If DOI envisions ALMRS to be the home of all land title records for the department, then it may be useful for those automated records to be housed in the GDS with department-wide responsibility. The same could be said for the land title records of the Forest Service and other federal agencies. Every agency would have access to these records electronically, no matter where they were housed.

Two factors may stand in the way. First, ALMRS will be used in BLM for functions other than land title records, and it therefore may be inappropriate to place responsibility for the system in another organization. Second, ALMRS is still in the testing and deployment stage, and therefore is not yet a fully proven, operational system. Full deployment is now scheduled for June 1998.

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* NPR has set forth a number of principles to guide the establishment of what are now widely called "performance based organizations" (PBOs). The President's 1997 budget also set forth criteria for PBOs. The following is a restatement of the presidential and NPR principles:

- The PBO must have a clear mission, with broad support from stakeholders.
- It must focus on ends (and customers) rather than means; that is, it must concentrate on outputs, rather than inputs.
- It will function under a three-to-five-year "framework agreement" that sets goals and authorizes the PBO to use more flexible personnel, procurement, and financial management procedures.
- Operations must be separated from policy-making and regulatory activities, which will be conducted outside the PBO.
- The chief executive will be compensated at market rates, and will be held accountable for results; appropriate rewards or sanctions will be provided.

NPR and OMB decided not to make the ability to raise revenues a condition for the creation of a PBO.

In technical comments on a draft of this report, BLM took strong exception to the idea of consolidating federal survey staffs into a PBO. The agency said the Panel and staff had not studied the issue in sufficient detail, did not have a full understanding of the extent to which survey and land title functions were integral to other BLM operations, and had not provided evidence that savings would be achieved by combining the survey staffs of the different federal agencies. BLM also said: "Coordinate positions will never replace a monumented property corner for a landowner to use in identifying legal property rights."

The Panel agrees that additional study and analysis would be required before making a firm decision on combining survey staffs and creating the PBO. The Panel and staff were briefed by BLM officials, and project staff interviewed or met in groups with many additional BLM staff, and they visited and toured several field offices. However, there was only limited opportunity to meet and talk with Forest Service or other agency survey staffs or to obtain quantitative evidence on the resources devoted to these functions or potential savings from consolidation.

The Panel based its judgment about consolidating the survey and land title functions on its experiences with other support-type functions elsewhere in government and considerations of what would be the appropriate components for the GDS as well as the synergies that could be achieved by bringing these components together. It therefore is recommending only that DOI "consider" creating a PBO for federal surveying and land title functions. It would be up to the federal task force chartered to develop a reorganization plan for the GDS to make final decisions on what components should be included.

Even as further analysis is being performed on establishing the PBO, the Panel encourages BLM, the Forest Service, and possibly other agencies to experiment with consolidating some of their field offices, especially where such offices are located near each other. At one point in its technical comments, BLM said: "Our customers are demanding that BLM and USFS consolidate offices to make acquiring information easier, more cost effective, and less confusing." It cited the "Trading Post" initiative* being implemented by the two agencies to reduce costs by sharing resources (personnel, facilities, competencies) and to provide "seamless service" to customers.

Aeronautical and Nautical Charting

The Academy's 1996 panel report on nautical charting and geodesy[xvi] concentrated primarily on the question of how to fashion a performance-driven, businesslike organization for these functions. However, it went one step further by recommending that they be transferred to DOT. That panel was concerned that the high risks facing the nation's shipping, ports, and waterways from out-of-date and inaccurate chart, tide, and current data demanded a higher priority and increased funding. The panel was not optimistic about the prospects for obtaining the needed support from NOAA because, with a budget 30 times larger than that for the functions reviewed by the panel, it had not hitherto seen fit to give them a higher priority.

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* The Fiscal Year 1998 Appropriations Act for the Department of the Interior and Related Agencies includes language allowing the Secretaries of the Interior and Agriculture, in FY 1998 through 2002, to make reciprocal delegations of authority, duties, and responsibilities in order to further joint pilot programs to promote customer service and efficiency between the Bureau of Land Management and the Forest Service in the management of public lands and forests, provided that there is no extension or altering of existing applicable public laws or regulations regarding the management of such lands.

The panel chose DOT as the appropriate location because it would be sound policy to assign charting and geodesy functions to the agency whose major purposes they most directly supported. The rationale for such a transfer was similar to that underlying the administration's proposal to transfer aeronautical charting to FAA, whose mission it directly supports. Further, DOT has a long and successful working relationship with DoD. The Academy's nautical charting and geodesy panel believed that "DOT would not have allowed a dispute with DMA to reach a point where DMA refused even to discuss the funding and service issues further." Finally, the panel noted that DOT already had many responsibilities relating to transportation safety, and regarded safety as a high-priority concern. Therefore, it was thought "very likely" that the department would push strongly to bring nautical charting to the level of currentness and accuracy that it demanded for aeronautical charting.

As for DOI, the panel believed that assigning nautical charting and geodetic survey functions to USGS probably would not have significantly improved the agency's reputedly "second class" status in competition with more scientific programs, although it would not likely have been "any worse off" than with the existing mapping functions of USGS. The panel report said: "The question of priority would ultimately depend on the attitudes of DOI and USGS leaders, and on their ability to 'sell' the program to Congress, should it decide to propose more resources for it than has NOAA."

The Panel for this study sees a significant difference between the assignment of nautical charting and geodesy functions to the GDS, compared with USGS, even though it supports NGS's transfer initially to USGS. These functions would be housed initially in an agency with like functions and many opportunities for programmatic and operational synergy. It would come under a new charter assigning these and GDS's other functions the exciting and challenging task of creating a robust NSDI. There would be "science," for sure, but it would be science designed to advance GI technology.

NOS rejected the 1996 report's recommendation to transfer these functions to DOT. The head of NOS at the time, Stanley Wilson, stated in a letter to the Academy president that the report's premise that DOT's mission was based on safety was equally applicable to NOAA, and there were other reasons for keeping the programs there, including utilization of these programs to support international trade and protect the coastal environment in support of the Commerce Department's commitment to sustainable development. Wilson also noted the increased support given recently by the Administration and Congress to nautical charting and geodesy. For fiscal year 1998, the House Appropriations Committee has provided further increases in funding,[27] especially for nautical charting, but those increases had not been approved by Congress as this report was being written.

For these reasons, the Panel for this study is more hesitant about advocating the transfer, especially of nautical charting, to a new location. However, it is convinced that the benefits of having geodesy associated with other base GI functions outweigh the synergies of retaining NGS in the Commerce Department. Its services would be equally available to Commerce programs as they would be to DOT and other federal agencies. The Panel acknowledges that NGS has a close relationship with a number of DOT programs, and there is merit in considering a transfer there, but geodesy is such a fundamental element in the GI foundation that it would be serving a larger national purpose by being located in the federal government's primary agency for base GI, the USGS and then the GDS.

As for aeronautical charting, the Panel sees this as primarily a programmatic function in support of the FAA's public safety mission and statutory responsibilities. The Administration has set plans in motion for the transfer to DOT in fiscal 1999, and there is no compelling reason to disturb them.

In policy comments on the draft of this report (see Appendix J), NOS took exception to the Panel's recommendation to create a GDS, stating in part, "A distributed, well-coordinated NSDI with each 'node' of the infrastructure specializing in its unique aspect of GI will be more effective because it will continue to allow GI programs to remain linked to their important public policy missions while at the same time requiring their feedback into the NSDI. It is the diversity of applications and uses that will help ensure a robust and relevant NSDI."

Regarding the transfer of NGS to USGS and eventually to the GDS, NOS said in part that:

- "the future of geodesy is in positioning things that move, i.e., the future of NGS is more relevant to commerce and transportation than the mission of USGS. The study itself confirms that under NGS' state geodetic advisor program the advisors are usually located in the transportation departments of participating states
- "there is no cost/benefit analysis justifying the move
- "there is no evidence that the NSDI will be furthered or that services will be improved by the move
- "the study does not fully consider that NGS works regularly with other NOAA programs such as the Forest Systems Lab, oil spill response in Hazmat, tidal predictions, nautical charting, and coastal and marine fisheries management"

The Panel understands and appreciates the concerns expressed by NOS about the proposed transfer. Certainly, much can be accomplished through interagency cooperation and electronic information exchange, but experience in DMA demonstrated positive results from integrating geodetic and the map-making functions. Also, notwithstanding the relationship between geodetic and transportation functions, there is the fundamental role of completing and maintaining the National Spatial Reference System, cited by the NGS director as having first priority, which is highly relevant to maintaining the foundation layers of the NSDI. The choice of location was guided, in part, to emphasize creation of a GI base to serve the whole nation while continuing to meet immediate program and customer-related needs. For those organizations clearly engaged in base GI functions, the Panel believes an NGS within GDS could better meet the needs of creating a GI base without adversely affecting current customer support.

The Special Case of Census TIGER Files

The U.S. Census has long required the use of GI to help accomplish its mission, particularly for the location of public roads used by people to reach their residences. Accordingly, a landmark agreement was carried out between the Census Bureau and the USGS/NMD to develop a national geographic database in a digital form for use in the 1990 Census. TIGER has been a base for multiple public and private sector GIS applications since then.

Easy availability of TIGER and geographically referenced socioeconomic data from the Census Bureau and other sources, in addition to providing source data for the census, have stimulated and served as the data foundation for many new GIS applications. For example, these data have been used with GIS by numerous individuals and organizations to more effectively analyze conditions and allocate resources for health, human, and social services; public safety, emergency management, and criminal justice; economic development and planning; and other governmental functions. These experiences have demonstrated the potential for significant improvements in the future delivery of these government services. Moreover, TIGER is commonly credited with catalyzing the rapid growth of the GI industry, not only in terms of incubating more value-added data and service providers, but in generating increasing demand for GI and GIS in an expanding array of business sectors and applications, such as target marketing, retailing, product and service delivery, financial services, and insurance.

While the public and private sectors alike recognize the value and benefits from this investment, the federal government is now challenged with maintaining the currency and improving the accuracy of TIGER. This is increasingly evident and vocalized by the GI community as efforts are made in anticipation of the year-2000 census, and state and local governments develop digital data that could be incorporated into the database. At the same time, the current and accurate location of roads appears to be the greatest challenge for the federal government regarding GI, and at the same time, is one of the country's greatest needs.

Given the multiple uses of TIGER and its relationship to the base data for which the GDS would be responsible, the Panel believes that consideration should be given to having the base geographic component of this function, now conducted by the Geography Division of the Census Bureau, transferred to GDS. Plans and arrangements could be made upon establishing GDS for censuses beyond that for the year 2000 so they would benefit directly from the work of GDS. Part of this task would be for GDS to work with the DOT and state and local governments to develop a maintained national road network. Efforts along these lines are now under way in NMD, DOT, and elsewhere which will provide a point of departure for GDS.

This move and GDS's long-term institutional infrastructure would enable these data to be more effectively developed in coordination with other data development, and maintained in a regular rather than cyclical manner between censuses. At the same time, these data would be readily available to the Census Bureau as needed at required intervals. The Geography Division is also responsible for the Census's master address file, and this role would be retained by Census. Benefits of this approach would be numerous and synergistic. Since the division already has established relationships with an ever-increasing number of local governments, this would solidify and help develop an intergovernmental infrastructure needed to build NSDI content cooperatively. It would also encourage stronger linkages between localities and states for the area integrators, and then up to the federal government for national coverage. Most of all, the resulting data would be of greater accuracy and currentness than the existing

1:100,000 scale of TIGER, eliminating the need for reconciliation of inaccuracies due to differences in scale. Thus, the data could be more effectively utilized in government and commerce alike. Some of this work could be contracted out as well.

Location of the GDS within DOI

The Panel considered several options for the location of the new organization: an independent agency like the General Services Administration, an instrumentality in either the Department of Commerce or DOI, a government corporation, or a private, nonprofit organization.

The roles and functions to be performed by the GDS relate most closely to organizations already in the DOI, and the core components include units of the USGS and BLM. The secretary of interior is also the federal government's principal land manager, and he chairs the FGDC. Most of the staff and funding for the programs that make up the GDS also are now under the jurisdiction of the department, so there would be less disruption. A legitimate case could be made for the Commerce Department because it already is home to NGS and the Coast Survey. It also has standards-setting functions in the National Institutes of Standards and Technology and information technology-related programs in the Technology Administration and National Telecommunications and Information Agency. In addition, Commerce has a broad mandate to advance economic development in the United States. The Panel favors DOI for the reasons stated above.

The Panel does not favor a stand-alone independent agency because there are already numerous such agencies in existence, and it does not want to advocate further fragmentation. Also, independent agencies traditionally have fared less well in funding and other priorities without a strong proponent in the form of a cabinet secretary. Also, independent agency heads generally have less access to the President than members of the cabinet.

An option to create a new government corporation is not feasible because revenues from services would not approach its costs under any conceivable scenario, and it therefore could not be self-supporting. This is one of the basic requirements, generally, for creating a government corporation in the United States.[28]

A public-private or nonprofit organization also does not fit well with the mission and functions of the GDS, many of which are inherently governmental in that it would assure that base geographic data continues to be available to all citizens and be responsible for U.S. land records and boundary determinations for federal lands.

Need to Phase in GDS Mission, Concepts, and Structure

The Panel believes NGS should be transferred to USGS as soon as authorizing legislation could be drafted and enacted. Such legislation also could authorize establishment of the GDS and provide for a reorganization plan to be submitted to Congress describing how this would be accomplished.* However, before final decisions can be made about the mission, composition, and structure of a GDS, a federal task force formed under an OMB mandate formulated in cooperation with OSTP should scope out the GDS based on the model presented below, prepare a transition plan, and formally present it to the administration and Congress. The NSDC would be consulted on the design of the field structure and delegations of authority.

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* Legislation recently passed the Senate (H.R. 1757, 105th Congress) to restructure the foreign affairs agencies. The bill broadly outlines how these agencies will be restructured but leaves the details to the State Department and other affected agencies. They are to submit a reorganization plan 15 days after enactment. A similar procedure could be followed for the functions to be incorporated into the GDS.

The Panel has been made aware of plans in USGS/NMD to test locally the concept of "place-based" or geographically defined areas of interest for data integration. NMD sees these areas as the underpinning of true partnerships, because they define an application area rather than a more traditional, and perhaps arbitrary, administrative unit. Examples of these "places" might include ecosystems, watersheds, river corridors, forests, or coastal zones. What is unique about these places in contrast to administrative units is that they are defined by problems or an issue that can be studied and perhaps solved by applying geospatial information – a motivating factor that provides a strong incentive for interested parties and stakeholders (including multiple levels of government, the private sector, and academe) to work together toward the common good as well as satisfying unique mission requirements.

The "test-bed" proposal is designed to focus resources on four or five places and make long-term commitments by the stakeholders in these places to test the technical, institutional, political, programmatic, and financial aspects of a shared database development and maintenance approach to satisfy the applications identified that are of interest in the selected geographic area.

This is a useful proposal which can provide useful data for designing the GDS, provided the tests can be conducted within a reasonable time period. Ideally, NMD needs to involve the other federal agencies doing base GI functions as well as address unanswered questions about the feasibility and cost of NSDI data sets developed cooperatively by different levels of government (see Chapter Two). The secretary of interior should use his personal auspices to enlist other agency cooperation, as necessary.

The Panel strongly urges that the tests be conducted over a limited period of time – not more than two years – and that results be independently evaluated and reported promptly. Testing should not be a substitute for action or cause unnecessary delay in implementing the GDS.

Conclusions

Regarding the structure and organization for federal GI functions, the Panel concludes that:

- Federal agencies engaged in GI are working together better than in past years, driven by budget stringencies, technology, and threats to their very existence; however, except for USGS/NMD, they are still primarily responsive to meeting agency program requirements and customer needs, not building an NSDI.
- Technology is bringing together GI activities once performed separately, that is, cadastral surveying, geodesy, and mapmaking, but the federal government is not structured to take full advantage of these synergies.
- Relationships with regard to GI among federal agencies and state and local governments are unnecessarily fragmented as a result of separate networks of state advisers and other competing liaisons.

- Differing field office jurisdictional boundaries make federal-state-local government relationships more complex, especially at a time when economic and environmental issues have become more prominent.
- There are potential opportunities to consolidate or otherwise restructure major federal GI activities or otherwise share capabilities that could advance further development of the NSDI. This applies to the agencies that provide base GI products and services, i.e, the four agencies sponsoring this study, and others as well. Transferring the NGS to USGS would be a useful first step.
- Establishing a GDS provides an opportunity to bring together base GI functions in ways that would enable further decentralization to the field, facilitate better engagement with other sectors, and reduce costs to governments and data-users.
- The new concepts behind a GDS and their cost implications need to be examined and an implementation plan prepared by a federal agency task force led by OMB in cooperation with the NSDC.
- The Administration's proposal in the 1998 budget to transfer current NOS's aeronautical charting to DOT moves this program to its major user and is reasonable.
- Assuming NGS is transferred to the DOI, nautical charting would be the only major GI function left in NOS, an arrangement that might prove to be inefficient and untenable. However, there is considerable synergy between nautical charting and NOS's other coastal management responsibilities and there is no pressing need to relocate nautical charting for other programmatic reasons. At the same time, nautical charting could benefit by being associated with the other base geographic functions proposed for the GDS, including continued association with the geodetic function. On balance, the Panel believes there is merit to merging nautical charting with other base geographic functions, but further analysis would be required before reach a definitive conclusion.
- The Forest Service's Geometronics Service Center (GSC) produces the base GI for about 20 percent of USGS' nationwide coverage and uses these to derive forest maps and other products. In the long run, as these USGS and Forest Service products become digitized, consideration should be given to combining these activities and reorienting GSC to be the Forest Service's GIS support center.

Recommendations for Immediate Action

- **Forward to Congress legislation to transfer NGS to USGS and authorize the establishment of a GDS contingent upon submission of the reorganization plan prepared by a task force mandated by OMB.**
- **Consider creating a performance-based organization within DOI for federal surveying and land title records activities.**

Recommendations for the Longer Term

- **Develop a reorganization plan, in cooperation with the NSDC, to implement the GDS and realign the federal field structure for base GI.**
- **Consider transferring responsibility for TIGER file maintenance, after the 2000 census, to GDS.**

ENDNOTES

[1] U.S. Office of Management and Budget, *Report of the Federal Mapping Task Force on Mapping, Charting, Geodesy and Surveying* (Washington, DC: July 1973), p. 1.

[2] National Research Council, *Toward a Coordinated Spatial Data Infrastructure for the Nation* (Washington, DC: National Academy Press, 1993), p. 114.

[3] House Committee on Ways and Means, *Report on Department of Commerce Dismantling Act,* 104th Cong., 1st sess., 1995, H. Rept. 104-260, p. 13.

[4] Senate Committee on Governmental Affairs, *Hearing on Improving Management and Organization in Federal Natural Resources and Environmental Functions,* 104th Cong., 2nd sess., June 27, 1996.

[5] *Ibid.*, p. 53.

[6] U.S. Office of Management and Budget, *Papers Relating to the President's Departmental Reorganization Program, A Reference Compilation* (Washington DC: February 1972), p. 132.

[7] OMB, *Appendix, Budget of the U.S. Government,* Fiscal Year 1998 (Washington, DC: GPO, 1997), p. 276.

[8] Public Law 104-201, *Chapter 22 - National Imaging and Mapping Agency,* Sept. 23, 1996.

[9] Cadastral Survey, http://www.cadastral.com (August 1997).

[10] U.S. DOI, BLM, *Public Land Statistics* (Washington, DC: GPO, 1996).

[11] GAO, *Land Management Systems: Progress and Risks in Developing BLM's Land and Mineral Record System,* GAO/AIMD-95-180 (Washington, DC: August 1995), p. 3.

[12] GAO, *Land Management Systems: BLM Faces Risks in Completing the Automated Land and Mineral Record System,* GAO/AIMD-97-42 (Washington, DC: March 1997).

[13] U.S. Forest Service, Geometronics Service Center, *Summary of USDA Forest Service Geospatial Activities* (Salt Lake City, UT: November 1996), p. 8.

[14] USGS, http://www.usgs.gov/bio/USGS/mission.html (September 1997).

[15] USGS, *National Mapping Division Strategic Plan* (Washington, DC: 1997), front cover.

[16] NOAA, http://www.noaa.gov/acc (September 1997).

[17] NOAA, http://www.noaa.gov/ocs (September 1997).

[18] NOAA, http://www.ngs.noaa.gov/who.html (September 1997).

[19] USGS, *Strategic Plan,* pp. 10–19.

[20] NRC, *Promoting the National Spatial Data Infrastructure through Partnerships* (Washington, DC: National Academy Press, 1994), pp. 3–4.

[21] NRC, *Toward a Coordinated Spatial Data Infrastructure for the Nation,* p. 89.

[22] E.O. 12906, *Federal Register* (Vol. 59, No. 71, April 13, 1994), 17671–17674.

[23] Federal Geographic Data Committee, *Development of a National Digital Geospatial Data Framework* (Washington, DC: April 1995), p. vii.

[24] *Ibid.*, p. 13.

[25] Frederick J. Doyle, "Map conversion and the UTM Grid," *Photogrammetric Engineering and Remote Sensing* (Volume LXIII, Number 4, April 1997), p. 367.

[26] National Academy of Public Administration, *A Performance Based Organization for Nautical Charting and Geodesy* (Washington DC: National Academy of Public Administration, June 1996).

[27] House Committee on Appropriations, *Departments of Commerce, Justice and State, the Judiciary, and Related Agencies Appropriations Bill, Fiscal Year 1998,* 105th Cong., 1st sess., H. Rept. pp. 105-207, 81-82.

[28] National Academy of Public Administration, *Report on Government Corporations,* Vol. I (Washington, DC: National Academy of Public Administration, 1981).

CHAPTER 6

Balancing the Roles and Functions of the Government and Private Sectors

GI applications, as well as producers and users, represent a convergence of federal, state, local, public, and private interests. The wide array of purposes served by GI argues, as the concept of an NSDI suggests, for a highly variegated set of institutional interrelationships. The NSDI needs to engage the tiered governmental structures of the U.S. political system and secure the active participation of multiple facets of the private sector involved in GI collection, processing, integration, and dissemination. The former extends from the federal agencies – over 40 of which are already engaged in GIS in one form or another – through the states to county, township, and local city or village jurisdictions. Regional, tribal, watershed, and ecosystem governmental groupings often play a large role.

Underpinning much of this growing governmental use of GI is a robust and rapidly advancing private sector. This includes a large number of aerial photography and photogrammetric companies, hardware and/or software GIS vendors, value-added resellers and data suppliers, data integrators of GI for almost everything – from farm soils to urban streets, from river reaches to utilities, from population and demographic censuses to wildlife and forest surveys – and a network of publishers, printers, and distributors of both hard-copy and electronic-map products. They will soon be augmented by commercial satellite imaging companies which would like, at a minimum, to sell their data to governments or even assume a greater role as suppliers of finished geographic products to governments, businesses, and the public.

This chapter addresses the distribution of roles and functions for GI among this multifaceted array of public and private interests. It responds to one of the key questions addressed to the Academy by the sponsoring agencies:

> *If some functions are deemed suitable to be commercialized, privatized, or transferred to nonfederal governments, what would be the effectiveness and economic impact of those transfers?*[1]

The distribution of GI functions has been itself an ever-changing landscape, one where the lines between government and private roles and among governmental layers are unclear. In reaction to rapid technological change and real-life problems, the distribution of GI roles is evolving rapidly, not always in a particularly clear and precise direction. This sometimes confusing, often kaleidoscopic, panorama of interests will continue to evolve. This chapter is intended to illuminate some areas of interaction, to point in the direction of steps that can be taken to alleviate conflicts and resolve differences, and to promote a balance among the multiple governmental and private sectors so that a truly national spatial data infrastructure can more quickly and efficiently become a reality.

DETERMINING GOVERNMENTAL FUNCTIONS

As discussed in Chapter Three, a vast array of public purposes has historically been served, and is currently being supported by GI. Some, as that chapter notes, are fundamental to a well-ordered society – nautical and aeronautical safety, public roads, congressional redistricting, postal services, and, of course, national defense. Some are recognized explicitly, or at least implicitly, in the Constitution. Many find a basis in federal statutes concerned with agricultural and natural resource management, environmental protection, community development, delivery of public services, and even historic preservation. Some are uniquely or predominantly federal – national defense, for example. Most share public purposes with state, local, and/or tribal governments which have their own authorities under local or state charters. Public land records, land-use planning and zoning, natural disaster mitigation or recovery, ecosystem, watershed, and environmental management are functions that cut across traditional governmental layers.

There is general agreement that geographic data, much like economic data, are indispensable to governmental management of many of these basic constitutional and statutory purposes. Thus, it is felt, governments have an inherent responsibility to assure that a significant library of GI is available for its own and the public's use. Such considerations led to much of the federal government's traditional mapping and surveying activities – nautical charting for inland and coastal marine safety, uniform national topographic maps at a scale of 1:24,000 for the conterminous 48 states, and, later, aeronautical and air terminal charts. Block census data, accurate locations for environmental monitoring of air, water and soil quality, and geologic and hydrologic mapping respond to other inherent responsibilities. These are areas of GI in which federal, state, and local governments share interests in acquiring and analyzing GI; similarly, the private-sector has substantial equities in many of these same areas. School district boundaries, and land-ownership records, which distinctly are of more local – state, county, and/or city – interest, clearly also respond to legitimate governmental needs.

As time passes, public purposes change because of technological advances and many other factors. Thus, it is important to consider criteria for reevaluating the GI roles of governments, determining the extent to which they are appropriate for the current era, and deciding which roles might be realigned among governments and between the public and private sectors. These criteria might include the following:

- Which GI programs are essential to support or are needed in public policy-making by federal, state, local, and/or tribal governments?
- Is nationwide coverage and consistency of GI essential to the public interest, and would this role be undertaken by the private sector?
- What types of GI are needed to guarantee compliance with and enforcement of governmental regulations, such as environmental protection?

- What types of historic information are required for scientific, policy-making, and legal purposes?
- What legal liability stemming from the quality and use of GI should the government assume to enable the availability and use of such information?

GI purposes are discussed in detail in Chapter Three and are summarized here. These purposes address the current programs of the federal government. The first two focus on meeting current needs, while the last addresses the nation's long-term competitiveness and leadership by helping to keep U.S. GI practices at the cutting edge of technological innovation. These purposes are:

- to ensure GI availability to support federal policymaking and operational responsibilities. Programs that meet criteria are:
  - USGS's program, which responds to the imperative for a common national database that would be met only spottily if left to a private-sector focused on "marketable" production
  - NOS's nautical and aeronautical chart production, which assumes federal government legal liability for the accuracy and reliability of its public safety products and, as with USGS's products, coverage would be spotty if left entirely to a market-driven private sector
  - NOS's NGS, which creates a common geodetic network on which other federal government levels, the states, localities, and the private sector can uniformly rely, a task unlikely to be commercially viable in the absence of a national cadastre
  - BLM's PLSS, a system of records and monuments focused heavily on federal public lands, which is the closest analogue to a national cadastre in the United States
  - Land management data, such as that collected by the Forest Service, BLM, the National Park Service, and other federal land managers, which is statutorily mandated or judged as prudent for the stewardship of federal public lands
  - Block demographic census data, which meets constitutionally-required redistricting purposes, environmental data which is prescribed for the safety of water, air, and soil, and data needed to protect endangered species and maintain biodiversity
  - Dissemination practices and policies which promote greater public participation in governmental affairs by ensuring ready access to data at non-discriminatory prices
- to ensure that federally-imposed requirements on state, local, and tribal governments for GI are reasonably attainable and consistent. The following respond to this imperative:
  - HUD community development plans
  - DOT's highway mapping and its planning support for the Intermodal Surface Transportation Efficiency Act
  - EPA's support for state and local governments' GIS systems to monitor environmental quality

- to help improve geographic data quality and accessibility through standards, a national clearinghouse, and data archiving, and to support basic geoscience research for the benefit of an expanding array of users
  - FGDC's standards efforts respond to this purpose
  - FGDC's national clearinghouse for geospatial data promotes greater GI accessibility, and USGS's EROS Data Center serves as a central archive and warehouse for remote sensing and unclassified imagery
  - The programs of the National Science Foundation and other agencies support the nation's basic earth science capabilities needed to maintain the United States' leading edge in geographic-related information technologies

Nonetheless, the large public purposes being serviced by GI provide no precise guideposts for defining the "inherently governmental functions" to be performed by government employees at whatever level. The federal government's basic policy on the relationship between governmental and commercial functions is contained in *OMB Circular A-76: Performance of Commercial Activities.*[2] This circular makes it U.S. Government policy to "retain inherently governmental functions that are so intimately related to the public interest as to mandate performance only by Federal employees." It clearly delimits "inherently governmental" functions to those activities which require the exercise of discretion in applying government authority or the use of value judgment in making decisions for the government. Examples it cites include selection of program priorities, direction of federal employees, and regulation of the use of oceans, navigable rivers, and other natural resources. With regard to GI activities, A-76 provides a lengthy list of examples of commercial activities – activities where the government might inappropriately compete with the private sector. These specifically include automatic data processing, aerial photography and photographic processing, mapping and charting, architectural and engineering services, geological surveys, printing, real property construction, road maintenance, landscaping and dredging.

The federal policy letter[3] governing determinations about what is inherently governmental lists examples that include the "act of governing," binding the government legally, affecting the rights of individuals, exerting ultimate control over public affairs, and managing government contracts. However, the policy letter states that "inherently governmental functions do not normally include gathering information." The policy also provides that commercial enterprises may perform governmental functions that are not inherently governmental. Generally, these activities are contracted out, or "outsourced."

In real life, the delineation of "inherently governmental" GI activities is in flux. The monumented and documented geodetic control points that form the national geodetic reference system, originally established by the federal government to tie the nation together, are now being densified by state and local governments under a federal standard. These, in turn, are increasingly being used as a means to eliminate the distortion and angle of (i.e., rectify) aerial and satellite imagery, and, soon, commercial satellite imagery. Topographic maps, long built to demanding cartographic standards, are increasingly being supplemented by orthophotographs, a product readily derived from most commercial aerial or satellite imagery that shows more detail with greater accuracy, but loses some traditional map content, such as elevation data. And city block data, long the basic mapping unit used by the Census Bureau for its demographic data, and local city street maps are being replaced or supplemented by electronic versions of street maps available over the internet and used increasingly in automobile navigation. Thus, the traditional lines between governmental and private sector roles are blurring as technology and consumer interests change.

Conclusions

The Panel is convinced that the division between inherently governmental and private-sector activities is changing, will continue to shift, and is best settled by consensus agreement rather than reliance on predetermined or philosophical judgments. In many cases, governments will continue to have a legitimate interest in ensuring availability of GI with wide public access. In those instances entailing government liability for the data, as in the case of nautical and aeronautical charts and forest maps, the government will want to exercise greater control. But, more and more, the private sector will want very similar data for commercial or business geographic reasons and may, at a price, make it available to governments. There is no reason to attempt to preclude appropriate resolution and accommodation by preemptively narrowing the role of either. The lack of a clearly defined division between governmental and private-sector roles is not unique to GI; responsibilities for economic data, societal trends, and many other types of information are, similarly, not neatly parceled out. This may result in some temporary uncertainties, even some healthy duplication and competition, between the sectors.

Thus, the Panel has concluded that the public purposes served by GI, as described previously in Chapter Three and above, are extensive and will continue to be fundamental to a broad range of governmental activities. The GI functions that need to be performed by government employees and retained as "inherently governmental" are clear – the government must retain the appropriate resources, technological skills, and personnel to conduct contract administration and ensure contractor performance. As private-sector capabilities continue to grow, governments will need to focus on carefully maintaining the technological skills of its personnel and contract monitoring capabilities while simultaneously utilizing a highly dynamic private sector.

ASSESSING THE DEVOLUTION OPTION

For much of the past two decades, there has been pressure to reevaluate the federal government's roles. Options have included returning some responsibilities to state and local governments and privatizing other responsibilities. As the era of big government ends, the ideas of reducing federal taxes and allocating governmental responsibilities at levels as close to citizens as possible are being examined. Devolution is the process whereby activities formerly performed at a higher level of government are passed down to be performed, with or without funding support, at a lower governmental level.

Devolution has been a recurring theme in recent federal resource and policy actions, particularly for deliveries of social services. Responsibility and authority are increasingly being shared with state and local governments for selected activities, rather than have them controlled exclusively by federal entities. A recent, high-profile example of devolution was the Welfare Reform Act of 1996 in which states were given direct funding and program performance roles. More recently, the fiscal year 1998 budget agreement provides funds and shares responsibility with the states to improve health care for needy children. Devolution can also extend to federal or state functions transferred to county and/or city levels.

When the 104th Congress convened in January 1995, there were proposals to abolish federal agencies, including both USGS and the Department of Commerce; the latter is where the geodetic control and navigation charting functions of the government currently reside. Although more than 250 other programs, offices, divisions, and independent agencies were "put out of business" during the 104th Congress, neither USGS nor Commerce were among them.[4] Nevertheless, a leading conservative think tank in Washington DC renewed its call for the 105th Congress to continue restructuring, closing, and consolidating federal agencies and programs. This call is contained in a long chapter beginning with the following paragraph:

> Any meaningful government reform agenda must include as one of its major components a comprehensive effort to weed out and eliminate those programs and departments that have outlived their usefulness or whose activities are more properly performed at the state or local level.[5]

Pragmatic analysts, such as Alice Rivlin and Paul Peterson, have proposed devolving major geography-based physical development programs such as highways, and other infrastructure, and community development to state and local governments.[6] Thus, at this particular point in history, there is significant political pressure to devolve additional governmental responsibilities to state and local governments. Under this sort of political pressure, many long-established federal goals are brought into question. A reduced federal workforce may not be able to achieve them the same way it once did. It is prudent to ask whether the federal GI programs, accumulated over the past 200 years, remain relevant and essential to the core functions of today's federal government. Could they be achieved by the state, local, or tribal governments?

Notably, the federal government has not recently devolved any significant responsibility for mapping, surveying, or natural resource management to the states or other governmental units. In GI activities, the focus has been on federal-state and state-county intergovernmental partnerships, rather than devolution. Some of these are statutorily mandated in such areas as transportation planning, community and economic development planning, environmental regulation, public service delivery of numerous types, and emergency management planning and operations. In the first two areas, federal funds frequently pay for establishing and maintaining geographic systems and require geographic data reporting to the federal government and the populations served. In the environmental and emergency management programs, federal agencies are developing automated GI systems that are available for acquisition by their intergovernmental partners with their own funds to do a better job.

Although these federally legislated activities have very limited constitutional imperatives behind them, some federal financial responsibility is implied since most of them are or were part of federal aid programs, such as highway funds, Superfund cleanup, and crime reduction. There are exceptions, for example, in the environmental regulation area where former federal aid levels have been reduced or were never available. In fact, the growing imbalance between federal aid and unfunded federal regulations led Congress to enact the Unfunded Federal Mandate Reform Act of 1995, which attempted to limit this practice. Nevertheless, state, local, and tribal governments remain responsible for collecting and using required GI appropriately whether or not the federal government provides adequate assistance. The consequences of less than adequate federal participation, of course, are likely to be less effective and efficient GI collection and integration and additional political tensions.

In addition to legislatively mandated devolution, there are numerous examples of executive branch action to promote partnerships in lieu of devolution. The growth of federal-state partnering in GI activities in recent years, driven in part by federal resource reductions, is more the result of federal agency initiatives than congressional dictates. USGS has been particularly progressive and partnering has more than quadrupled since 1992. Interagency and state partnering in production of orthophotoquads is now the norm, and USGS will not undertake orthoimagery production without at least 50/50 matching funds. Through shared funding and/or work-share arrangements, states assume responsibility for everything from aerial photo acquisition to digital elevation production. One particularly innovative program has been with the State of Texas where USGS, acting on behalf of itself and other federal agencies, and the state shared funding under a state contract with an in-state producer of orthoimagery. At the state level, Wisconsin, a leading GIS practitioner, is funding county governments to develop cadastral maps and modernize land information systems to the state's standards and timelines.

Studies by the U.S. Advisory Commission on Intergovernmental Relations (ACIR) found that the allocation of functions among the various levels of government hinges on the observed comparative advantages for economic efficiency, fiscal equity, political accountability, and administrative effectiveness related to specific activities.[7] Seldom does it make sense to think about a whole function of government being best suited to a particular level of government; instead, the individual activities within the function are where the clear comparative advantages show up. ACIR found distinctions between the activities (or components of governmental functions) of planning, financing, staffing, administration, standard-setting, enforcement, service delivery, information, and evaluation. It is logical to assume that many GI activities are appropriate for decentralized execution.

This approach is not without pitfalls, however. ACIR found that the devolution of federal responsibilities to state and local governments was often promising, but frequently required time-consuming state executive and/or legislative action and entailed politically difficult adjustments.[8] Transition devices, ACIR recommended, were needed to avoid sudden fiscal and administrative shocks; such devices should be consistent with the extent of the decentralization, the simplicity of the plan, the certainty of alternative funding, the adequacy of future revenues, and the effects on fiscal discipline.

The Panel examined several candidate GI activities for possible devolution to state or local jurisdictions, including devolution of the public lands record system, base cartographic mapping, and production of digital orthophotoquads. The long-standing federal PLSS complements state, local and private land records, but devolution would impose a heavy burden – particularly on western states where federal land dominates and where issues of land ownership and encroachment are common. Similarly, state and local governments have interests in base cartographic mapping. Some have substantial capacity, but the fiscal and technical capacities of many states are limited. Digital orthophotoquads, a product particularly useful to local and private landholders, currently benefits from substantial federal funding and federal quality control that might be compromised if product responsibilities were devolved.

Conclusions

The Panel concluded that devolution has not been, nor is it likely to become, the approach best suited to accomplishing the objectives of an NSDI. Increased partnering between government echelons rather than devolution is preferable. Most of the goals of an NSDI have required, and will continue to require, intergovernmental coordination and cooperation as opposed to unilateral product responsibility. It would not be prudent to devolve substantial major land record, base cartographic, or orthophoto production responsibilities on states and local governments that are unprepared.

The Panel found that the GI capabilities of states and localities need to be strengthened. Empowering their GI groups, adopting and implementing national standards, promoting greater linkages with counties, cities, and other local jurisdictions would greatly improve their ability to build the NSDI.

Similarly the Panel concluded that federal agencies and the FGDC, for their parts, need to coordinate better their work with state, local, and private-sector GI groups, support state and local programs responsive to federal government data needs, and encourage greater awareness and understanding of the value and utility of NSDI, including FGDC standards, clearinghouse, and partnership efforts. In Chapter Five, the Panel recommended specific actions to strengthen federal activities in place-based GI, eco-regions, and problem-oriented task forces, and to harmonize federal-state GI work through explicit state liaisons.

Recommendations

- **No specific federal GI functions should be devolved at this time.**
- **State and local governments should establish GI coordinating groups or focal points responsible for serving as the points of contact responsible for NSDI coordination and cooperation.**

EVALUATING PRIVATIZATION ALTERNATIVES

The term "privatization," as used here, means commercialization or full privatization, where functions and full responsibilities are shifted from the government to the private sector. The sale of a government asset – a building, an inventory, and/or enterprise – is often involved, and the government generally has no continuing role in financial support, management, regulation, or oversight, though it may temporarily act to incubate private sector capabilities.

If shrinking the federal government is an objective, privatization, by giving the private sector full responsibility for performing a function, is as good an answer as devolution. And, if shrinking the combined federal, state, and local establishment is the goal, privatization is an even better answer. However, this approach does not necessarily consider the consequences for performance of established public purposes. Generally, a purpose becomes public because there is no profit motivation to perform it, or because the profit motive would leave significant segments of the population unserved and out of the mainstream of productive contributors to the nation's economy. Nevertheless, the private sector is very good at doing many things, and there are many proposals now to shift more responsibility to the private sector.[9]

Many of the recent innovations in GI coordination in federal, state, and local governments and regional planning organizations are largely based on the availability beginning in the mid-1980s of user-friendly and affordable GIS hardware and software. These systems either can be bought "off the shelf" and installed and operated by the government, or they can be installed and operated by private contractors. Both methods have been used. In addition, the private sector has fully qualified capabilities for performing surveying, photogrammetry, and cartographic data collection, analytical, and other GI functions. Governments at all levels, in fact, make extensive use of these private services. The primary public purpose issue in this regard is the need to maintain enough capability within government to be able to ensure the quality and cost-effectiveness of the private sector work for governmental purposes and to make effective public use of the information generated by these means.

As public policy and public purposes change, there are federal GI activities where privatization could be considered. For example, much of USDA's mapping of private farm lands will no longer be required to enforce statutory crop and acreage restrictions as these are phased out under the terms of the Freedom to Farm Act of 1995. Senior USDA policy officials see the requirement for GI for these purposes fading. Similarly, Congress has clearly stated that the National Biological Survey, now the Biological Resources Division of the USGS, should not expend funds to monitor ecological and wildlife trends on private lands, assuring that the private sector retains the opportunity to service the private market for this information. Thus, changed public purposes have created clear opportunities for the private sector to provide these types of GI.

The Panel considered several possible candidates for privatization during its deliberations. These included:

- current governmental recreation mapping in which almost all federal landholders support recreational land use by the public in its parks, forests, wilderness areas, flood control projects, and hydroelectric sites
- production of digital raster graphics (DRGs), scanned images of paper maps
- increasing privatization of street mapping to support automated automobile navigation systems

Conclusion

There appear to be clear governmental cost savings implicit in privatizing some of these activities and relying on the private sector to produce many of these products, even if market incentives are inadequate to provide uniform nationwide coverage. Private sector capabilities and market interests are growing rapidly, and the Panel is confident that governments and the private sector can and should find the means to accommodate their common purposes and interests. The Panel concluded that privatization of GI activities and governmental reliance on contracting out or outsourcing are shifting with the growth and capacity of the private-sector GI industry, changing public purposes, and growing business and personal consumer markets for GI. These changes require flexible approaches, rather than recourse to dogmatic or philosophical solutions, to the balancing of GI functions. Nonetheless, the Panel noted that there are potential liability and quality assurance difficulties that would need to be addressed and concluded it was premature to endorse specific privatization candidates. No specific candidates for privatization are recommended at this time.

In addition to privatization, there are alternative forms of government organization and operations that incorporate aspects of commercial business practices, but are not equivalent to privatization. Some examples are:

- managed competition, where agencies compete with private bidders for their own or another agency's work
- government corporation or performance-based organization, where revenue-producing, commercial-type services are performed by separate entities free from, or having considerable flexibility for, personnel, procurement, and administrative functions. An ESOP, or employee stock ownership plan, is a variation of this form in which the government continues to regulate certain aspects of an activity in which the activity's personnel become private stock owners of a firm performing tasks formerly performed by government employees.
- franchising, where the government grants a concession or privilege to a private-sector entity. The government may regulate the service level or price, but service users pay the providers.
- public-private partnership, sometimes referred to as a joint venture, where a contractual arrangement is formed between public- and private-sector partners that can include the development, financing, ownership, and/or operation of a public facility or service. Typically, public and private resources are pooled, responsibilities divided, and income shared in direct proportion to investment. In contrast to a typical service contracting out or outsourcing, the private-sector partner usually makes a substantial at-risk equity investment.

Naturally, there are mix-and-match variants that are potentially achievable and applicable to a wide variety of governmental activities in general and to GI activities specifically. Currently, for example, there are aspects of managed competition in aerial photography acquisition, where government aviation assets, acquired for other purposes, in effect compete for some tasks with private-sector capabilities. Franchising on National Park Service lands of lodging facilities is extensive, and public-private partnerships in map data distribution are widely used.

One area of caution for the government is engaging in value-added activities that are not required for governmental functions. This has happened abroad where quasi-governmental organizations, utilizing the government's copyright or data ownership prerogatives, have expanded into revenue-generating value-added activities to support their base GI activities. The Panel concluded that this approach was not appropriate for governments in the United States.

Recommendation

- **Government agencies should avoid engaging in value-added activities beyond the research and development phase when they can be provided by the private sector at or near government cost.**

The BLM sought clarification on this recommendation, but agreed that agencies should not be enhancing or creating products for the sole purpose of selling them for a profit. Forest Service disagreed with the term "value-added" as used in this context. It argued that the responsibility and accountability for content and quality of information provided as base geographic and derivative products is "inherently governmental." The Panel's recommendation was intended to discourage both profit-motivated value-added activities and those value-added activities in which the private sector are clearly competitive. It is not intended to dilute the agencies' responsibility for the content or quality of the information required for its functions, whether produced in house or under contract.

Clearly, there are increasing opportunities for commercial-type operation of some current GI activities, as discussed in Chapter Five. In a previous study, for example, an Academy Panel found that NOS's nautical charting and geodesy activities were suitable for transition to a performance-based organization, such as the United Kingdom has implemented for land-mapping through its Ordnance Survey. There could also be an extension of the current use of a large number of private map distributors for federal government map products; a performance-based organization might be able to assume the bulk of the remaining federal map and chart distribution functions. Finally, as discussed in Chapter Five, a performance-based organization for federal surveying and land records that is open to competition from the private sector was suggested.

CONTRACTING OUT OR OUTSOURCING OPTIONS

Federal Policies

Circular A-76 is OMB's long-standing, broadly applicable, and highly visible policy addressing the relationship between federal government and commercial activities. If a function is not inherently governmental, A-76's criteria for determining whether an operation is to be performed internally or contracted out entail comparing the cost of contracting versus in-house performance to determine which entity will do the work. A-76 directs the government to use the commercial sector if a commercial product or service can be procured more economically. A-76 includes a lengthy *Cost Comparison Handbook* for use by agencies in developing government and private-sector cost comparisons. When last revised in 1983, A-76 called for all agencies to review within four years all existing in-house commercial activities and to report annually on implementation of A-76.

OMB and GAO, however, have been unable to evaluate the costs and benefits of this 40-year-old policy, and promises of accountability through evaluation must be treated with healthy skepticism. Agency implementation of A-76 has often been more in the breach than the norm in initiating, continuing, or evaluating government programs. DoD, at times, has been precluded from conducting any A-76 cost comparisons or from implementing contracting out, and most agencies experience considerable anxiety when confronted with mandatory A-76 evaluations. A-76's failure to serve as an effective arbiter between governmental and commercial performance of activities is well-documented and served as the basis for numerous efforts at reform. In 1981, GAO concluded that "as many as 400,000 federal employees are currently operating more than 11,000 commercial or industrial activities" and urged Congress "to legislate a national policy of reliance on the private sector for goods and services."

In 1984, the Office of Federal Procurement Policy Act specifically required that each executive agency also designate a competition advocate to promote acquisition of and a competitive process for commercial goods and services. Departments engaged in GI have competition advocates at the departmental level, but their primary focus seems to be on ensuring a competitive environment for contract activities, rather than promoting outsourcing. More recently, many DoD components, including NIMA, have moved to designating a commercial advocate to promote outsourcing as an alternative to in-house performance. As the federal government moves to performance and results-based evaluation of its activities under GPRA, the opportunity for these advocates to address commercial opportunities more directly is likely to improve.

Again, in 1993, the NPR, led by Vice President Gore, advocated improvements in outsourcing government functions. The Vice President's report concluded that 7,000 federal employees (including over 3,800 in DoD) and $1.0 billion are devoted to surveying and mapmaking; it concluded: "Mapmaking is a service that is readily available from private industry at competitive costs. All government mapmaking activities should be opened to bids from private-sector suppliers."

In 1995, a White House Conference on Small Business strongly recommended that Congress prohibit agencies from engaging in commercial activities in direct competition with small business. In 1996, a Defense Science Board Task Force, chaired by Academy fellow Philip Odeen, concluded that DoD could reduce support costs by 30–40 percent by outsourcing services.[10]

Criteria for Considering the Outsourcing Issue

In the mixed, public-private economy of the United States, there are constant shifts among four sectors: pure government, government enterprises, government purchases from the private sector, and commercial enterprise.[11] Table 6-1 shows the relationships among the four sectors and provides a framework for exploring them: The four sectors of the economy result from the interplay of two dimensions: (1) who pays, and (2) who delivers the service.

TABLE 6-1: DIMENSIONS OF THE PUBLIC/PRIVATE CHOICE

	Collective Payment	**Individual Payment**
Public Sector Delivery	Regular Government	Government Enterprises
Private Sector Delivery	Government Purchases	Commercial Enterprise

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Source: John W. Donahue, *The Privatization Decision: Public Ends, Private Means*, (Basic Books, 1989), p. 7.

In the regular government sector, services are paid for collectively through taxes, and the services are delivered by the government. An example, in the geography-based public purpose context, is in public-land management, particularly, outdoor recreation use, where access by users is free or subject to very low entrance or use fees that do not approach the public costs involved. The operating philosophy is to pursue the public interest for the greatest benefit of the largest number of taxpayers.

In the government enterprises sector, a government corporation or special authority delivers the service, but most or all of its costs are paid for by those who benefit directly and pay benefit charges or fees. Examples in the present context are TVA and the Pacific Northwest Power Authority. Both are funded primarily by utility charges, though they collect recreational fees and other lesser revenues as well. The organizing philosophy is cost recovery and businesslike performance.

In the government purchases sector, the government pays, but the private sector delivers the service or product. Examples include contracting out (or outsourcing) for photogrammetry, the building and launching of satellites and remote sensors, property line surveys, and GIS hardware and software. About 50 percent of all government spending is in this category, and the Clinton Administration has taken action to make it easier for government agencies to buy "off the shelf" to reduce paperwork and get needed equipment and supplies quicker and cheaper.[12] The guiding philosophies are to take advantage of expertise that the government does not possess and to buy products and services less expensively than the government could produce them. The cost savings are spurred by competition in the commercial marketplace.

Finally, the commercial enterprise sector includes entities, such as regulated private utilities and deregulated transportation companies – in the geography-based public-purpose context – as well as the rest of the nation's private companies. The operating philosophy is competition, efficiency, and customer satisfaction, leading to maximum profits. Businesses are paid privately for products and services delivered to private persons by private enterprises. With the exception of government taxes on business profits and regulation of business practices to protect the public interest, there is no government role in this sector of the economy.

There is no single right answer to the question of which public purposes should be met in which sector. Times change, and the answers change with the times. All four quadrants are used to meet public needs. At any given moment, the Constitution and the laws enacted by Congress provide the answer to what should be the proper balance among the four sectors, or the array of options that may be used.

Changes, in fact, have been proposed in recent years that would very significantly affect the current geography-based public purposes of the federal government. Nevertheless, within the current legal framework, activities identified in the federal column in Table 3-2 (see page 42) for 12 geography-based public purposes are responsibilities that federal agencies are currently accountable for meeting, using GI as a resource. They have the option of outsourcing many of the GI tasks of data collection, maintenance, product production, and product distribution, and both Congress and the administration are urging agencies to use this option more.

Under the official federal government guidance defining inherently governmental functions cited above, many GI activities that do not involve the exercise of discretion in applying government authority, binding the government legally, affecting the rights of individuals, exerting ultimate control over public affairs, or managing government contracts may be performed by commercial enterprises. The policy says explicitly that "inherently governmental functions do not normally include gathering information . . ."[13]

Another way of describing the relationship between inherently governmental functions and candidates for outsourcing is the state and local government formulation in which an inherently governmental function is called provision of the service (deciding that it should be provided and finding the funding to support it), while production of the service (actually producing the product or delivering the service) is defined as not inherently governmental.[14]

The outsourcing decision should be made carefully, considering the following criteria:

- It should be clear exactly what the government is purchasing, how the purchase will be in the public interest, and what the price will be. (If unclear, it either should not be contracted out or should be outsourced using a cooperative agreement under which the government and its partner jointly agree on the major decisions made during the term of the agreement and find their way together.)
- The purchase should be at or below the cost of performing the service in house.
- Outsourcing should meet quality requirements.
- The government must be able to hold the contractor accountable for performing acceptably within the terms of the contract.

Although these criteria appear obvious, it is not always easy to adhere to them. For example, GAO found in a review of 100 contracts made by four federal agencies that the government sometimes did not have the capacity to manage the outsourced work effectively.[15] GAO concluded that, in some cases, the government relied on the contractors so much that the contractors were, in fact, performing inherently governmental functions. The lesson of this study is that federal agencies must retain the level of expertise and administrative capacities needed to administer contracts effectively. A later GAO study of privatization in state and local governments also found that "monitoring contractors' performance was the weakest link in their privatization process."[16]

The cooperative agreements mentioned above are illustrated by CRADAs used by USGS to create jointly administered research and development partnerships with private industry. Grants to the private sector to encourage research and the development of technology are another variation on the purchase of services; they may be used to support activities having a strong possibility of public benefit, but uncertainty about exactly what the benefit might be.

For the distribution of government maps, public documents, or other geographic-data products, franchise types of arrangements with the private sector might be appropriate. The retailing of USGS and Census products are examples.

Congressional Guidance

In recent years, Congress has been the leading source of increasingly specific guidance applicable to GI activities. In 1988, the Brooks Act that required qualification-based selection for architectural and engineering services was expanded to include surveying and mapping services as well. In 1995, the House Appropriations Committee report included guidance to USGS to "continue to increase its contracting of map and digital data production, with a goal of no less than 50 percent contracting by the end of fiscal year 1997 and no less than 60 percent contracting by the end of fiscal year 1999." This committee similarly directed the Navy in 1995 "to obtain any future photogrammetric service from the private sector." Both Senate and House appropriations committee reports in 1995 also pressed for NOAA's mapping and charting programs to rely increasingly on the private sector, and said it expected "hydrographic, geodetic, and photogrammetric surveying and mapping services shall be awarded in accordance with [the Brooks Act]". DMA, now NIMA, was similarly urged by Congress to develop a strategy for contracting mapping, charting, and geodetic activities with the private sector, and the secretary of transportation was directed to encourage the states to utilize the private sector for surveying and mapping activities under DOT's highway program.

This congressional pressure for increased outsourcing coincided with burgeoning private-sector capabilities in surveying, mapping, and GIS technologies and increased lobbying on behalf of private sector firms. MAPPS cites the existence of more than 6,000 surveying and 250 mapping firms in the United States, employing more than 40,000 persons. This confirms the 1995 report of the Defense Science Board which, in its review of DMA, found that rapidly expanding commercial imagery and mapping capacities were overtaking government capabilities. An Integrated Product Team (IPT) is now in place in NIMA, in conjunction with the OGC, to advance the process of better utilizing private-sector capabilities in commercial imagery acquisition, feature extraction software, standards development, desktop printing, and internet-like data dissemination. The draft report of this joint industry-government effort concludes that the IPT "confirmed the findings of the DSB" and that the lessons learned "demonstrate the feasibility of addressing issues through new technologies and business practices." The commercial sector capabilities determined to be advantageous in national security mapping tasks have been demonstrated to be similarly applicable to civil mapping and GI generally.

More recently, a bill (S. 314) entitled The Freedom from Government Competition Act was introduced in the 105th Congress. This bill would preclude agencies from carrying out any activity performed by the private sector and from obtaining such goods and services from another government entity. While there are exceptions for such activities as inherently governmental functions, national security, quality, and best value, the bill characterizes government competition with the private sector as inherently unfair. It would provide that OMB establish a commercial activities center to ensure implementation and compliance. In public testimony, USGS went on record in opposition to this approach as increasing government's cost and discouraging the type of cooperation and coordination recommended in order to promote the NSDI. Similarly, ACSM opposed action on the bill until more is known about its likely impact, particularly with regard to technical fields, such as surveying and mapping where public-based and private-sector professionals currently have an interdependent and generally cooperative relationship.

Finally, in the House Appropriations Committee report on the fiscal year 1998 budget for DOI, the committee modified its earlier percentage guidelines for USGS outsourcing. It commended "the significant progress made by USGS in increasing its contracting of map and digital data production" and concluded that "the evolution of the program from a concentration on map and data production to a broader information-management role suggests to the Committee that the need for a specific contracting goal . . . is no longer appropriate. . . ." The committee, however, urged "USGS to continue to pursue greater use of commercially available capabilities."

Sponsoring Agency Approaches

The practices and policies of federal GI agencies in conducting A-76 cost-comparison studies and implementing competition and/or commercial advocates is extremely spotty. In DOI, USGS and BLM reported no A-76 cost studies have been conducted on surveying, mapping, and other GI activities during the last five years. DOI did identify two A-76 cost-comparison studies conducted in the last five years that compare government-owned versus leased aircraft services performed by BLM; though predominantly transportation and not GI-related, the one study that supported government-owned aircraft services showed a savings of about $125,000 annually on a cost of $850,000 for private services. While DOI has a designated competition advocate, the advocate seems to be focused on competition among private vendors, not assessing questions of in-house versus contract performance. Though USGS has conducted no recent formal A-76 studies, it cites its use of cost-comparison information available from its annual review of the reimbursable work it performs for its customers to help determine work apportionment between in-house and contract production.

One of NOS's A-76 evaluation and cost comparisons, done in the early 1980s, was of its nautical and aeronautical chart distribution function, and it led to contractor operation of its major Riverdale MD facility; currently 41 government personnel are retained to handle order-taking and receipt collection, functions that were regarded as "inherently governmental" at the time of the study. NOS also studied in-house versus contract costs and performance of nautical chart production and National Geodetic Survey activities in the mid- to late 1980's and concluded it should retain these activities in house. The Forest Service reported only one A-76 cost-comparison study in recent years(a 1992 assessment of its aerial photography program in its Intermountain Region. The Forest Service noted that its managers often conduct informal cost comparisons of in-house and contract prices; it recognizes that personnel funding commitments are often part of this less formal process.

With respect to the performance of individual agencies, the following briefly discusses their outsourcing practices, experiences, and trends:

USGS's National Mapping Division (NMD)

Between fiscal years1992 and 1996, NMD moved across the board to increase its contracting-out efforts as shown in Table 6-2. Excluding one-time acquisition of its advanced cartographic system, contractual spending has increased from 26 percent of total spending in 1992 to 35 percent in 1996, and this trend is expected to continue into fiscal year 1998 when contractual efforts will grow to almost 40 percent. The simultaneous reduction of total personnel from over 1,700 in 1992 to less than 1,200 planned in 1998 appears related to this contract growth.

TABLE 6-2: USGS NATIONAL MAPPING DIVISION

	Percent of Total Obligations Outsourced[1]			
	Actual			**Plan**
	1992	1994	1996	1998
Total Obligations[2]	**26[3]**	**25**	**35**	**40**
Data Collection/Processing	25	24	42	54
▪ Surveying	(0)	(0)	(72)	(80)
▪ Aerial Photo/DOQs	(76)	(56)	(75)	(80)
▪ Other Mapping	(19)	(16)	(24)	(35)
Printing	13	12	24	24
Distribution	10	11	14	14
Data Storage	62	75	74	78

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[1] Agency response to the Academy's data request, April 1997.

[2] Total obligations grow from $162 million in 1992 to $184 million in 1998.

[3] Reflects large outsourced procurement of Advanced Cartographic System (ACS).

This trend seems to be particularly pronounced in the areas of data collection and processing, where overall contractual efforts grew from 25 percent of data collection and processing obligations in 1992 to 42 percent in 1996; the contract percentage is expected to grow to almost 54 percent in 1998. Major areas of contract growth within the data-collection and processing area have been associated with rapidly increasing production of DOQs and DRGs; both of these products are virtually 100-percent outsourced.

Some areas like the National Aerial Photography Program (NAPP) have been almost exclusively contracted in the last several decades. USGS owns no aircraft, and none of the mapping photography it acquires for itself or in conjunction with the current six NAPP agencies or the states is done in house. Full coverage of the conterminous 48 states is accomplished every five or six years to serve as the basis for regular cartographic updates, orthophotoquad production, and as a uniform base for most mapping needs. NAPP has served to aggregate most federal – and some state and local – aerial photography requirements at substantial savings to taxpayers and been effective in curtailing expensive duplication. USGS has been effective in coordinating multi-agency aerial photo requirements and collection under the NAPP, orthophotoquad requirements and production, and the archiving of remote-sensing data at its EROS Data Center. In contrast, government coordination of requirements and collection of non-NAPP photography, LANDSAT and SPOT imagery, and future commercial satellite imagery has been limited. In part because of the absence of effective coordination in these areas, LANDSAT commercialization and security policies have retarded governmental use of remote-sensing data.

Contracting out in several other areas has grown substantially. The percentage of control point surveying has grown from none to a projected 80 percent in 1998. Contracting for commercial production of DEMs, DLGs, and land-cover characterization is growing from about 20 percent to 38 percent between 1992 and 1998. These activities are in the area of data collection and production where MAPPS has pushed for outsourcing, and thus, the area USGS cites where outsourcing is growing from 35 percent in 1992 to a projected 60 percent in 1999.

Quality control and quality assurance is one area of data collection and processing where USGS follows different procedures for different products. Contracted DEM production, for example, is checked for quality by government employees on a sheet-by-sheet basis; there are known areas of difficulty in DEM production (edge-matching, shorelines, steep terrain, etc.) where contractors might be inclined to shave costs.[17] In contrast, USGS contends that quality assurance in DOQ production is less technically demanding; quality assurance is handled much more by separate monitoring contractors with more limited quality checks by government employees.[18]

There has been a very modest increase in contracting of the printing and distribution function at USGS. Some printing of non-map products is handled by GPO or, through GPO, by contractors, but USGS has one of the three five-color presses owned by the government (NIMA and NOS have the others). USGS's press is used to print most map products. Thus, less than 25 percent of NMD printing is contracted. Print product distribution is predominantly out of NMD's centralized Rocky Mountain warehouse, which stocks over 131,000 different products and its network of 11 federal and 63 state-operated Earth Science Information Centers; it also utilizes some 2,500 commercial map sales agents in many localities. But less than 15 percent of distribution is contracted, mainly through contract employees augmenting staff at the warehouse and some sales centers.

In contrast, electronic and image data products are largely stored and distributed out of USGS' Eros Data Center in Sioux Falls SD, a contractor-operated facility with a growing percentage of its operation (now 78 percent) performed under contract. Many other NMD functions are contracted, including equipment maintenance, equipment and supply acquisition, and some research and development projects.

Conclusion and Recommendations

The ever-widening availability of high-quality satellite imagery and remote-sensing data should serve as a powerful unifying force promoting the NSDI and data integration. As commercial satellite imagery evolves, the NAPP serves as a useful model of efficient and effective federal interagency and intergovernmental coordination and cooperation. Without precluding those instances where imagery acquisition by individual agencies would be judicious, the federal agencies need to better coordinate their collection and acquisition of aerial, remote-sensing, and satellite imagery.

- **USGS, or the GDS recommended in Chapter Five, should be tasked to coordinate federal acquisition of imagery for civil government purposes from aerial platforms and classified intelligence, civil domestic, foreign, and commercial satellites.**

- **The USGS-led Civil Applications Committee should take the lead in interaction with the intelligence community and with international and commercial providers on civil governmental needs and encourage the greater utilization of these data.**
- **Federal agencies should lead and encourage other levels of government to be involved in remote-sensing activities through example and partnering.**

National Ocean Service (NOS)

Except for the distribution center mentioned above, which is predominantly contracted, NOS contracts out very little of its geodetic and charting functions. Less than 10 percent of its total activities of nearly $120 million is contracted out as shown below in Table 6-3.

TABLE 6-3: NATIONAL OCEAN SERVICE

	Percent of Total Obligations Outsourced[1]			
	Actual			**Plan**
	1992	1994	1996	1998
Total Obligations[2]	**8**	**9**	**9**	**8**
Data Collection/Processing	3	3	5	4
Printing/Distribution	37	39	37	37

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[1] Agency response to the Academy's data request, April 1997.

[2] Total obligations grow from $95 million in 1992 to $113 million in 1998.

Geodetic data collection and processing is less than 10 percent contracted, primarily in areas of surveying and maintenance of NOS's two aircraft, with only a small amount of aircraft support contracted. Some limited nautical and aeronautical chart compilation and data processing and some drafting and engraving and drafting terminal procedures publications (TPPs) are outsourced, but these activities account for less than 5 percent of NOS' work in these areas. Enroute charts, airport directories, and the TPPs are aeronautical products printed in book formats, and both printing and distribution are under separate contracts. Most other NOS printing is on its five-color press in the basement of the Hoover Building: the joint Transportation/Commerce Inspector General team that reviewed the location of aeronautical charting found that consolidating printing with USGS would save $2.3 million in the first year and $3.0 million annually thereafter; the team also found substantial private sector capability – five contractors with 10 presses readily available. The warehouse distribution of about $1 million is, of course, also contracted, but 41 government personnel continue to perform the "inherently governmental" order-taking and revenue collection functions. Like USGS above, NOS has an extensive network of private resellers – over 2,800 for aeronautical charts and some 1,200 for nautical charts located at many airports and boat yards nationwide.

NOS has made limited R&D funding available to its Coastal Services Center, which operates with local, state, and regional partners, on coastal-zone management and to experiment with new equipment. It has experimented through CRADAs with the digital distribution of its electronic charts. Some of its other cartographic production-related functions, such as supplies, equipment, and courier services, are contracted.

Bureau of Land Management (BLM)

BLM surveying, mapping and GI activities are strongly dominated by their cadastral survey responsibilities under the PLSS, including its current effort to establish a computerized database, the Geographic Coordinate Data Base, of geographically coordinated land and survey records. Over 80 percent of BLM's GI resources are devoted to these cadastral activities, with about 15 percent of its resources coming as reimbursements, primarily from other federal land owners (Forest Service, NPS, BIA, Reclamation, etc.) and privately financed mineral surveys. Its total GI resources have been declining from over $50 million in fiscal year 1992 to a projected $44.5 in fiscal year 1998. This downtrend is more pronounced in its personnel level, where the number of geographic science personnel, including surveyors, cartographers, and geodesists, has declined from 718 in 1992 to a current level of 539.

The bulk of BLM contracting also is for cadastral surveying, where outsourcing has fluctuated between 20 and 33 percent, as shown in Table 6-4, or $7-12 million annually. This compares to a fairly steady $28-30 million in non-contract survey costs that are performed by government employees. Though in-house survey personnel have declined by about 20 percent, the lack of new hires and attrition in junior ranks are generating higher average salary costs.

BLM's non-survey activities – its geoscience, mapping, aerial photography, and remote sensing – are comparatively small ($16 million in 1994) and are declining to about $9

TABLE 6-4: BUREAU OF LAND MANAGEMENT

	Percent of Total Obligations Outsourced[1]			
	Actual			Plan
	1992	1994	1996	1998
Total Obligations[2]	**28**	**35**	**25**	**24**
Data Collection/Processing	27	33	23	23
▪ Surveying	(24)	(30)	(19)	(20)
▪ Thematic Data	(38)	(36)	(34)	(36)
▪ Other	(44)	(56)	(48)	(38)
Printing/Distribution	100	100	100	93

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[1] Agency response to the Academy's data request, April 1997.

[2] Total obligations grow from $162 million in 1992 to $184 million in 1998.

million in 1998. The largest of these activities has been the collection and processing of thematic data on vegetation, wildlife, and other non-base cartographic data on BLM lands. Production of secondary base maps of BLM areas and aerial and satellite support for this production account for the bulk of its other activities. Contracting out is concentrated in the functions of imagery acquisition, printing, and equipment procurement. About 30-40 percent of BLM's base mapping and associated data collection and processing appears to be contracted out.

Forest Service

Forest Service surveying, mapping, and GI activities have been reduced from a peak of $72.7 million in fiscal year 1994 to $47.2 million in 1996 and a projected $41.5 in 1998. Surveying activities were extensively restructured in 1995 to move to a user-paid service which reduced the 1992 survey funding level from $26 million to less than $15 million in 1996. A large conversion of analog and tabular GI to digital data, and related software funding, also was substantially reduced. Most other GI activities took lesser reductions. In percentage terms, as shown in Table 6-5, a significant portion of the agency's spending has been contracted, including a large percentage of aerial photo collection and DOQ production, printing and distribution, and data-storage activities.

The Forest Service estimates that the number of personnel engaged in GI activities has been increasing and will continue to do so, based on widening Forest Service acceptance and spread of the GIS functionality in its new computer system, known as Project 615. The 1992–95 funding of this program and conversion of data to use with it accounts for a sizable portion of early-year funding, and the substantial tailing off in 1996–98.

TABLE 6-5: FOREST SERVICE

	Percent of Total Obligations Outsourced[1]			
	Actual			**Plan**
	1992	1994	1996	1998
Total Obligations[2]	**26**[3]	**25**	**35**	**40**
Data Collection/Processing	25	24	42	54
▪ Surveying	(0)	(0)	(72)	(80)
▪ Aerial Photo/DOQs	(76)	(56)	(75)	(80)
▪ Other Mapping	(19)	(16)	(24)	(35)
Printing and Product Distribution	13	12	24	24
Data Storage	10	11	14	14
Other GI	62	75	74	78

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[1] Agency response to the Academy's data request, April 1997.

[2] Total obligations grow from $69 million in 1992 to almost $73 million in 1994, but decline with $47 million projected in 1998.

Summary

In summary, the key surveying and mapping agencies above, show considerable disparity in their outsourcing trends. Table 6-6 shows the variation in outsourcing among the agencies in total obligations and in selected GI functions.

TABLE 6-6: VARIATIONS IN OUTSOURCING

	Percent Range of Total Obligations Outsourced[1]			
	1992	1992	1992	1992
Total Obligations	**8 to 40**	**9 to 35**	**9 to 38**	**8 to 40**
Highest	Forest Service	BLM	Forest Service	USGS
Lowest	NOS	NOS	NOS	NOS
Surveying	0 to 40	0 to 30	1 to 72	1 to 80
Database Collection and Processing	3 to 35	3 to 37	5 to 42	4 to 54
Printing and/or Distribution	10 to 100	11 to 100	14 to 100	4 to 93

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[1] Agencies' responses to the Academy's data request, April 1997.

Conclusions and Recommendations

While the range of variation is large, the nature of the agencies' differences, varying degrees of congressional pressure for outsourcing, and changes in overall resource levels, both in terms of dollars and personnel, seem to be the principal causes of these differences. The growth in USGS outsourcing under considerable congressional prodding is a clear trend. Outsourcing growth is particularly notable in (1) overall obligations, (2) surveying, where USGS has shifted heavily to contracting for geodetic control points, and (3) data collection and processing, where the product-mix shift to DOQs has heavily aided outsourcing. Trends in other agencies seem to be more mixed and as much a product of internal agency dynamics as any other force. BLM and Forest Service reliance on external printing and NOS's use of contractors for printing and distribution stand out. The Panel recommends that:

- **Outsourcing decisions should be made on the basis of the respective roles, responsibilities, and competencies of the governmental and private sectors.**
- **Cost-effectiveness is one of several factors that needs to be considered; on the other hand, arbitrary percentage targets for contracting out should be avoided.**

Other Federal and State Agency Approaches

No systematic effort to collect contracting-out (or outsourcing) data on other federal agencies engaged in GI activities was attempted during this study. However, there are indications that other agencies' data would be similar to the trends discussed above. Some examples provide further insight:

- ACE cited its long-standing policy, dating back to manpower shortages during World War II, of contracting out almost all of its surveying activities associated with U.S. military bases, both boundaries and project engineering. Largely at the insistence of Congress, the agency had followed an approach in its civil functions that was less oriented toward the private sector, but it has moved to greater contracting out as its personnel resources have been squeezed under administration guidelines. ACE officials acknowledged that the choice was largely politically, not technically, driven. ACE determined that it needed to retain a base in-house technical capability in order to maintain technical contracting savvy and offered a figure of 20–25 percent internal to 75–80 percent external work performance.
- State departments of transportation have developed considerable in-house aerial photography, surveying, and mapping capabilities in conjunction with federally aided highway programs. While there is an increasing trend to outsource these activities as state aircraft and surveying and mapping equipment wear out and as more stringent fiscal conditions prevail, the state departments of transportation retain substantial in-house capacity.
- States work closely with the federal government and often fund cooperatively contracted DOQ production. Texas, for example, entered into a cooperative arrangement in 1995 to produce DOQs for about one-third of the state. USGS served as the channel for funding from federal agencies and provided original source material to Texas. Texas contracted out DOQ production to a Texas-based contractor, in part under the rationale that this would help promote the state's economic development.

In 1995, Texas' Council on Competitive Government also queried state agencies on the attractiveness of outsourcing. Concerns about data quality, timeliness of availability, and cost predominated. There was considerable resistance to outsourcing GI applications by the state's resource, transportation, and social agencies. They invariably argued that their data was sensitive (historical commission), "unique" (transportation), involved department-generated databases (parks and wildlife), required tight time schedules (air quality, water planning), and involved the use of volunteers (oil spills) or interns (endangered resources). Up-to-date base topographic and digital orthophotography were most often cited as outsourcing candidates.

ADVANCING PARTNERSHIPS AND CAPACITY SHARING

Partnerships are not new. They have been around for many years. Federal partnering burgeoned in the 1970s and 1980s in response to recommendations, never implemented, to consolidate many mapping activities. Cooperative DMA-NOS data sharing for nautical and aeronautical chart production, the NAPP, USGS-Census cooperative development of the TIGER files, and the development of USGS-Forest Service "single edition" map series were early successes. And, as noted above, there has been a strong federal-state partnership in highway mapping since the mid-1950s, and geologic and hydrologic mapping have been cooperatively produced in conjunction with state agencies for many years. During a June 1997 field visit to Alaska, project staff noted strong cooperation among federal agencies and cooperation with the state's agencies. In the past, the land distribution requirements of statehood and oil pioneering had been delayed because of inadequate maps.

The pressures of declining resources, the emergence of an NSDI concept, and the endorsement by the MSC of partnerships as one of the key elements of creating it have further enhanced partnering in recent years. There has been a major expansion in federal interagency reimbursable funding as agencies move to use the skills of other agencies, and as they face downsizing and reinvention. For example, USGS reimbursable obligations more than doubled between 1992 and 1998, from $16 million to $34 million. USGS undertakes cooperative programs with a host of federal agencies: DoD as discussed in Chapter Seven, USDA including Forest Service and the Natural Resource Conservation Service, NOAA, NASA, EPA, AID, CIA, State, etc. Federal interagency reimbursements are also a major source of funding for NOS's nautical and aeronautical chart production; reimbursements will increase to over $32 million per year from the FAA for aeronautical charting in 1998 and there was sizable, but shrinking funding from NIMA, also discussed further in Chapter Seven. BLM and the Forest Service produce GI primarily to met their own land management needs, and their reimbursable funding is, therefore, substantially smaller.

Perhaps of more significance is the growing pattern of intergovernmental and private sector partnering. Though the total amount of federal, state and local funds devoted to partnerships is still small, there is a clear and dramatic pattern of growth. Table 6-7 below shows the growth in partnership funding by USGS's NMD, including the FGDC and the almost nine-fold increase in this approach. USGS is clearly in the lead in this activity, and the growth in other agencies' partnership funding has been smaller. The MSC's recommendations to increase geographic partnering coincided with federal resource constraints that had the effect of spurring intergovernmental and private sector partnerships.

TABLE 6-7: USGS PARTNERSHIP FUNDING[1]

	Dollars (Millions)		
	1992	1994	1996
Total	**0.8**	**4.7**	**7.0**
Innovative Partnerships	0.4	3.2	4.0
Work-share Agreements	0.1	1.0	0.6
Data Exchanges	0.3	0.4	2.2
Cooperative R&D Agreements	0.1	0.1	0.2

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[1] Agency response to the Academy's data request, April 1997.

The sampling of GI partnerships that follows demonstrates the breadth and diversity of these efforts:

- **Federal Interagency Partnering**
    - The Forest Service prepares and publishes 1:24,000 scale maps for lands in the national forests that correspond with USGS products. These account for slightly less than 20 percent of the 55,000 quads covering the 48 states.
    - USGS and three USDA agencies (Natural Resources Conservation Service, Farm Service Agency, and Forest Service) are cooperating in the National Digital Orthophoto Program. Most of the funding is from USDA, but states also organize and fund this program.
    - EPA and USGS are jointly creating and will maintain the National Hydrography Dataset. Initially at the scale of 1:100,000, the program is designed to incorporate and encourage development of higher-resolution data, to exchange data among the federal, state, and local governments, and to improve data updating.
    - In Oregon, the Forest Service regional office, a portion of the BLM state office, the Regional Ecosystems Office, and the regional ACE office are co-located in the same office building.
    - BLM and the Forest Service have developed joint customer service standards and interagency performance measures.
    - BLM and the Forest Service have combined some offices for adjacent public lands in Colorado and Oregon to provide one-stop service to their customers.
- **Federal Partnerships with Private, State, and Local Organizations**
    - USGS's NMD has a CRADA with ESRI to develop a spatial data editing program that will produce products similar to those produced by USGS. This is intended to become a commercial product.
    - Census has a CRADA with Geographic Data Technology, Inc. to determine a way to communicate electronically with local governments to create and maintain the database for the year-2000 census.
    - BLM contracts with Indian tribal governments in Alaska to survey over 13,000 acres of land for transfer to these governments.
    - NMD has innovative partnership arrangements with three states in which federal funds are transferred to the states to conduct work meeting federal and state requirements. In a cooperative agreement with the State of Texas, USGS aggregates funds from multiple federal agencies for transfer to the Texas Department of Information Resources. The latter similarly pools funds from multiple state agencies and contracts with the private sector to produce digital orthophoto quads according to federal specifications.
    - NOS has had a state geodetic advisor program since 1974 and places National Geodetic Survey employees in state government offices, usually a transportation department. Over 20 states participate in the program and provide funding and administrative support for these advisors. The advisors work with representatives of state, local, and private organizations and provide technical expertise to enable these organizations to conduct work that meets federal guidelines.

- USGS has recently designated a "state representative" in each state. These designees are usually from the Water Resources Division which has an office in each state. USGS also has traditionally worked closely with state geologists. A former NMD program that places a state cartographer in a few states was abandoned several years ago, but a new program of designating state NMD liaisons in individual states is being established — with eight liaisons in place. Each of these people will serve several states. The new USGS Biological Resources Division has employees in about 40 states, generally located in the cooperative extension service of the state university.
- Census makes extensive use of user advisory committees to hone its data-collection efforts and has established State Census Data Centers and affiliates through agreements with each of the states.
- In North Carolina and Florida, the Forest Service has a single field office with jurisdiction over all the Forest Service lands in the state, rather than for just for one or two forests, as is the case in the other states. This approach facilitated a partnership between the national forests of North Carolina and the state to develop GI.
- NRCS has an office located in each state with a designated GI coordinator; most have a full-time GIS specialist.
- EPA helped fund a land cover database for the states in its southeast region.
- FWS took the lead on a cooperative hydrologic boundary mapping project in Idaho to further a fisheries habitat study. Cooperating agencies included the Forest Service, BLM, and the state GI advisory committee. A standardized watershed boundary map for the state was produced.
- BLM districts and states share Forest Service contracts for printing recreational maps and purchasing photogrammetry.
- Individual Forest Service, BLM, and other agency field offices sometimes provide GI expertise and access to technology to nearby communities, while in other cases, counties have provided GI expertise and technology to federal field offices.
- BLM has partnership agreements with individual counties where BLM provides its GCDB and the county provides positional and control data from private surveys. Recent emphasis is on developing agreements with states that, in turn, develop agreements with counties for this purpose.
- BLM has placed two employees in the offices of the NACo, with roles that include GI coordination.

Several federal agencies, such as EPA, FEMA, and DOT, have relationships with their state counterpart agencies, upon which they rely to carry out their missions. In each case, the federal agencies have invested considerable time and money building up the capacity of the states to perform GI functions required by federal laws, and funds are regularly channeled to these state counterparts. For EPA, the states administer the federal pollution-control regulations. In cooperation with FEMA, the states prepare for emergencies, take preventive measures, provide immediate response, and lead recovery efforts. With DOT support, the states plan, construct, and operate transportation facilities and systems. In addition, federally required metropolitan planning organizations use federal transportation funds within their areas.

In most of these cases, federal agency funding provides significant support for GI. Furthermore, because state agencies are often similar to their federal counterparts, they also often use compatible approaches, data, and systems in order to transfer data to the federal level. These federal agencies also have significant regional or field structures to provide guidance and assistance to the states and others. EPA and FEMA have regional offices. The Federal Highway Administration (FHWA) has a strong field presence in each state and substantial contact with most of the nation's 340 metropolitan planning organizations. These relationships are not typically characterized as GI partnerships, and they exist outside FGDC and other federal interagency GI partnerships, but they offer significant opportunities for promoting an integrated NSDI if standards and practices are followed that will make this data compatible and accessible.

The message of these examples is that there are many GI partnerships of many different types involving the federal government. They are usually limited either geographically or by content. Most serve specific agency needs, and, while the agencies recognize the contribution of their activities to the NSDI, only a few are directly oriented toward establishing a robust, nationwide NSDI. Also, many of these partnerships involve only one or a few states and localities. This piecemeal partnering is commendable, but it is premature to conclude that a nationwide set of relationships is evolving that will achieve a robust, nested NSDI.

The Panel found that the primary factors promoting integration, cooperation, and data sharing have been, and are likely to continue to be, resource stringency – both in personnel and budgets – and the availability of new technologies such as the Internet and computing capacities that generate considerable efficiency savings in data manipulation and integration. There is general agreement that redundancies in data collection and production can, and should, be reduced with the savings used to finance additional GI activities.

GI partnerships are predicated and built on common interests among the partners. Therefore, it is essential to identify those common interests. The first step, then, is to identify partners and get them together. FGDC has been one mechanism for encouraging and facilitating partnerships with the federal government. Its CCAP, which facilitates interorganizational coordination and partnerships through demonstration projects, provides small, temporary grants to state and local entities to encourage collaboration and make them more NSDI cognizant, compliant, and capable. But CCAP grants have been limited, short-term, and competitive, rather than a source of long-term, capacity-building support.

Individual federal departments are the key partners. They have geographic data committees with varying levels of activity and involvement in partnerships. Many federal GI partnerships exist outside FGDC to meet the common missions of two or three agencies, though their efforts generally exist in accordance with and as a complement to FGDC direction and approaches. Even more partnerships exist between individual federal agencies, and states, and to a lesser extent, localities and other organizations. Here the recommendation in Chapter Four to create a NSDC would be particularly helpful. Virtually all states have some version of a similar GI group encouraging partnerships. In addition, many local governments participate with their neighbors in integrated approaches.

State and local agencies naturally prefer to partner with federal field staff located in their states. Sometimes their staff feel that they are more knowledgeable than federal field staff about the NSDI and FGDC activities and that the field staffs should have more authority to make decisions and commit resources for their agencies. The greater field autonomy exercised by BLM and USFS components is favored over USGS's and NOS's generally more centralized management approaches. In addition, state and federal partnerships are often difficult to negotiate and are sometimes constrained by funding limitations, legal requirements, and other impediments on the part of either partner. Many state and local officials find it difficult to understand why their data cannot be used to update federal databases, and federal officials are perplexed by the array of disparate standards and data formats at the sub-federal level.

Grants, cooperative agreements, work-share agreements, and memoranda of understanding (MOUs) are the principal tools used to consummate GI partnerships. Contracts might be used on occasion, but generally they are used for the purchase of a specified product or service, such as in outsourcing arrangements. The other tools for implementing partnerships are fairly straight forward, and there has been a great deal of experience with them, as indicated by the long list of illustrative partnership examples above.

One problem is that neither the federal nor state agencies have enough flexibility to negotiate a satisfactory agreement with potential partners, or there is a policy difference that cannot be resolved. Broader enabling legislation may be needed by some federal agencies to authorize practices that are taking place in some of the other agencies. For example, the double pooling of funds for a joint federal-state project — as in the example of NMD and Texas — might be more generally used. NMD has specific authorization to enable funding to be transferred to states to develop data, while other agencies rely on contracting.

The bigger problem in partnering may be the narrowness of some federal programs that develop and use GI. Agencies often have narrowly drawn programs with strict separations between them, and prohibitions on money passing between them. For this reason, there may be very little federal money to integrate diverse types of GI. That purpose simply has not been authorized. Broad NSDI enabling legislation could help to clear up such problems, to the extent that they exist.

Conclusion and Recommendations

The Panel concluded that multilateral partnering and consortiums are more likely to build the form of intergovernmental coordination and private-sector cooperation that the NSDI requires. Increasingly, consortiums, rather than bilateral partnering, are needed to meet the mutual geospatial data needs of multiple users and as a means to promote cooperation and data sharing.

- **GI resource managers should increasingly emphasize multilateral partnerships(interagency, inter-governmental, and with the private sector(both to promote a robust NSDI and as a source of savings.**

The Panel favors broad consortiums that involve multiple governmental levels and engage the private sector. The Panel recommends two specific actions to promote these approaches:

- **USGS's unique authority to engage in innovative partnerships should be extended to other agencies.**
- **Multilateral partnering, including CRADA-type partnering with the private sector on agency operational activities, should be increased.**

IMPACT OF PRICING POLICIES AND INTELLECTUAL PROPERTY RIGHTS

Federal GI agencies generally adhere to the pricing guideline contained in OMB Circular A-130; similar guidance is now incorporated in federal law. In brief, these guidelines state that the price federal agencies charge for federal government information should not exceed the cost of dissemination. An A-130 appendix describes this cost as the sum of all costs associated with preparing a product for dissemination and actually disseminating it to the public. It specifically excludes the cost of initially collecting and processing the information under the assumption that the data was acquired for the conduct of government business. Provision is made for charging for preparation costs associated with public dissemination, for additional costs associated with online public access (including hardware, software, and telecommunications enhancements), and for full-cost recovery of service costs for specialized products or special customers. Ultimately, however, the responsibility for determining user fees rests with each agency.

All GI agencies follow at least the spirit of these guidelines. USGS, for example, has applied these guidelines to its products, but with adaptation particularly relevant to GI and data. Its policies include:

- waiving cost recovery of an information product if it is determined the public good will be enhanced
- recovering the dissemination costs of metadata products and promotional information through sale of the information products
- explicit provision in joint-funding projects, cooperative agreements, grants, and work-share arrangements for full-cost recovery for products beyond those in the terms in the arrangement
- cost recovery for pre-processing, formatting, or staging of large databases prior to making them available
- free distribution over the Internet when the cost of collecting the fees represents a large portion of the distribution costs

These policies, when applied in today's world of massive electronically accessible digital geographic databases, raise questions about the future pricing of GI. Here are a few examples:

- USGS has put online its full set of 1:100,000 DEMs and DLGs, and a more limited set at 1:24,000, at no cost. In the context of an evolving NSDI, this could be viewed as promoting a public good and the cost today of collecting even a modest fee would be high. But what policies should be adopted for the upcoming era when widespread online GI of higher resolution data and economical electronic commerce are available?

- USGS has established a three-tiered pricing policy for data distribution over the Internet – free metadata, free base data, and cost recovery for frequent, long access, for extended connect times, and for tasks that require a significant amount of USGS intervention in terms of processing, formatting, or staging. Is this a price structure the GI community should widely adopt? And what should be included in the price?

These questions are all the more pertinent when the current lack of uniformity of pricing by state and local governments is taken into account. One commercial company stated that a majority of its requests for local government data usually met with a reply that no policy has been set on open access. Indeed, there are numerous cases where cities and counties are charging for GI at full-cost recovery; a few attempt full-cost recovery plus profit. In reality, nonfederal government pricing policies range from open access to full cost plus profit. Clearly these variances in governmental policies will, in the long run, impede the implementation of the NSDI and serve as a barrier to the vertical integration of data sets that is likely to be most cost-effective and generate the greatest savings.

The effect of pricing on GI utility and utilization is amply demonstrated by the adverse effects that LANDSAT commercialization had on state and local data availability and utilization. By agreement with the commercial contractor, federal users were granted favorable pricing terms, but LANDSAT data distribution was severely curtailed by marketing of this data at "commercial" prices to state, local, and private users starting in the mid-1980s. This adverse effect continues with current LANDSAT 4 & 5 data that remains subject to private distribution; this will not be changed until LANDSAT 7 launches next year. The commonality and coordination benefits that would have accrued to multiple government echelons from use of common LANDSAT data has been effectively deferred for over a decade.

An equally debilitating effect on data interchange with the private sector will be governmental pricing policies that jeopardize the intellectual property rights of private sector enterprises. A rigid governmental approach that requires that data acquired by the federal government be distributed at the cost of government reproduction will retard commercial efforts to market data to governments. A means that recognizes the intellectual property rights of private-sector companies both to collected raw data and value-added data is needed. Governments can effectively aggregate demand for private sector products that would otherwise prove non-viable in the marketplace, but it currently lacks mechanisms to do so. A mechanism that allowed governments to recover a portion of otherwise lost revenue is needed. A royalty fee or "site license," much like that used by software manufacturers, may be an approach that safeguards intellectual property rights in GI, while making more data available to more interested parties. Neither the federal government as a whole, its agencies, or the FGDC has an explicit policy on royalties for copyrighted material at this time, and its absence will almost certainly impede the type of data sharing and exchange needed to effectuate the NSDI.

Conclusions and Recommendations

The Panel found that federal data and pricing policies often conflict with state and local government and private-sector interests in generating revenue, a situation that is likely to be exacerbated as more data is digitized and becomes available on line. These constrain partnering to the mutual disadvantage of all sectors.

Recommendations

- **The federal government policy of promoting open access, especially for all data used in public policy decisionmaking, should be maintained and states and localities are urged to adopt similar policies.**
- **The federal government, possibly under the lead of the FGDC, should articulate a clear policy or draft legislation that allows the government to work cooperatively with the private sector to protect private-sector intellectual property rights for private and value-added GI data sets.**

ENDNOTES

[1] BLM contract with the National Academy of Public Administration.

[2] Circular No. A-76: Performance of Commercial Activities (Washington, DC: Office of Management and Budget, August 4, 1983).

[3] Office of Federal Procurement Policy Letter 92-1, September 23, 1992.

[4] Stuart M. Butler and Kim R. Holmes, eds., *Mandate for Leadership IV: Turning Ideas into Actions* (Washington, DC: The Heritage Foundation, 1997), p. 57.

[5] *Ibid.*, p. 55.

[6] Alice M Rivlin, *Reviving the American Dream: The Economy, the States, and the Federal Government* (Washington, DC: The Brookings Institution, 1992) and Paul E. Peterson, The Price of Federalism (Washington, DC: The Brookings Institution, 1995).

[7] U.S. Advisory Commission on Intergovernmental Relations, *Governmental Functions and Processes: Local and Area Wide* (Washington, DC), p. 7.

[8] U.S. Advisory Commission on Intergovernmental Relations, *Devolving Federal Program Responsibilities and Revenue Sources to State and Local Government* (Washington DC: February 1974), pp. 1–8.

[9] John D. Donahue, *The Privatization Decision: Public Ends, Private Means* (Basic Books, 1989), pp. 7–13.

[10] *Report of the Defense Science Board Task Force on Outsourcing and Privatization* (Washington, DC: Office of the Under Secretary for Acquisition and Technology, 1996).

[11] *Ibid.*

[12] President Bill Clinton and Vice President Al Gore, *Blair House Papers* (Washington DC: National Performance Review, January 1997), pp. 36–38.

[13] Office of Federal Procurement Policy Letter 92-1, September 23, 1992.

[14] U.S. Advisory Commission on Intergovernmental Relations, *The Organization of Local Public Economies* (Washington DC: December 1987).

[15] U.S. General Accounting Office, *Government Contractors: Are Service Contractors Performing Inherently Governmental Functions?* (Washington, DC; November 1991).

[16] U.S. General Accounting Office, *Privatization: Lessons Learned by State and Local Governments* (Washington, DC; March 1997), p. 6.

[17] Interviews with staff, Rocky Mountain Mapping Center, USGS.

[18] Interviews with staff, April 2, 1997, Western Mapping Center, USGS.

CHAPTER 7

Other Issues

This chapter addresses two key areas of GI:

- technology research and development
- relations between the civilian, domestic-oriented GI agencies and the defense and intelligence agencies covering primarily foreign lands

These two areas cut across many of the topics discussed in previous chapters, such as appropriate governmental and private-sector roles, consolidation and restructuring of activities, and the importance of GI to the economy and the nation. These issues merit focused treatment because of the significant impact of technology on GI and the important role of DoD and NIMA in geographic activities. As the nation moves toward an NSDI, it will be extremely important that R&D activities support the development of the necessary tools, and that the transition from federal to national, and ultimately to global activities proceeds in harmony.

GI TECHNOLOGY RESEARCH AND DEVELOPMENT

Major GI Technology Trends

GI technologies have advanced rapidly during the last several decades, paralleling the major advances in its supporting technologies – satellite and remote sensing, data processing, and telecommunications. Satellite and remote-sensing technologies have benefited significantly from government funding. Data processing and telecommunications technologies are largely the result of private-sector research and initiative. One key aspect of GI – value-added services – has been developed by government for such areas as defense and intelligence and by the private sector for civil applications. The significant developments in GI technologies discussed below identify major trends applicable to GI. These trends serve as a base on which to assess current government activities and the government's future role in promoting GI technologies

Remote Sensing

Remote sensing and imaging satellite developments have generated substantial interest in, and provided tremendous amounts of, geographic data. Satellite imagery technologies have made huge strides since the initiation of the first intelligence photo-reconnaissance satellite, CORONA, in 1960.[1] Its huge collection of imagery acquired between 1960 and 1972 is now declassified. Complementing these efforts, on the civil side, has been NASA's development of its earth-sensing satellite system, LANDSAT, and its nearly continuous operation of multispectral sensors since 1972 and its thematic mapper in operation since 1982.[2] These systems have contributed significantly to knowledge of the earth and provided ever-increasing volumes of land information.

However, these major historical contributions pale in comparison to recent and prospective technological advances in remote sensing.

- Intelligence satellite advances since the 2–4 meter resolution of CORONA[3] are classified, but there can be little doubt that they have been, and are likely to continue to be, spectacular in both capabilities and the volume of collected information.
- The now ten-year-old French SPOT imaging satellite has better resolution capabilities than the current LANDSAT's – 10 meters as opposed to 30 meters; and, SPOT is incorporating higher 5-meter resolution sensors in 2002.[4]
- New Indian remote-sensing satellites launched in late 1995 and in fall 1997 now offer near five-meter resolution.[5]
- Other unclassified systems, such as NASA's large format camera (LFC) and space-imaging radar (SIR) experiments and advanced NOAA weather satellite sensors, have greatly increased both the volume and utility of remotely sensed GI.
- The Global Positioning System (GPS), an equally phenomenal non-imaging satellite development, reached full operating capability in 1995. It has had a major influence on GI systems because of its ability to provide highly accurate point-positioning information. Its real-time capability provides better than 100-meter accuracy, and this can be readily improved to near-centimeter accuracy, a capability that revolutionizes the ability to geo-reference and record GI worldwide.[6]
- In 1998, NASA will launch the first of a series of multi-billion dollar Earth Observation System (EOS) satellites.
- NASA also plans new hyperspectral satellite experiments in 1998, and, jointly with DoD's NIMA, an advanced imaging radar for mapping and earth observation starting in 1999.
- USGS' EROS Data Center is planning an order-of-magnitude increase in satellite earth observing digital data by 2001 and a twenty-fold increase by 2005 as a result of these systems.[7] Major improvements in intelligence imaging satellite capabilities also can be anticipated.
- Four U.S. companies plan to launch earth-sensing and imaging systems in the next several years, some with resolutions down to one meter. Earthwatch and Space Imaging EOSAT are expected to launch initial systems this year. Orbimage and Resources 21, two companies with demonstrated space capabilities, also plan to launch earth observation satellites. Table 7-1 shows planned commercial remote sensing satellites planned to be launched between 1997 and 2001.
- Finally, most foreign countries are planning significant improvements in their next-generation remote satellite systems.

TABLE 7-1: PLANNED COMMERCIAL REMOTE SENSING SATELLITES

Spacecraft	Owner	Resolution	Launch Plan
Ikonos-1	Space Imaging Eosat	<1M	December 1997
EarlyBird	EarthWatch	3M	Late 1997
Ikonos-2	Space Imaging Eosat	<1M	September 1998
QuickBird-1	EarthWatch	<1M	Late 1998 or Early 1999
OrbView-3	Orbital Sciences	1M	1999
QuickBird-2	EarthWatch	<1M	1999
OrbView-3B	Orbital Sciences	1M	2001

Applications Technologies

In the 1970s and 1980s, applications advances closely paralleled aerial photography, remote sensing, and satellite developments. The private sector led in aerial photography acquisition technologies, aerial photogrammetric processing, and development of new remote-sensing applications. Major advances were made in using multispectral data to determine agricultural conditions, including soil moisture, erosion, and soil quality. New techniques were employed for current and predictive weather data using data from satellites and other systems to assess moisture, adverse weather, and fire warning conditions and to characterize vegetation patterns and problems. NASA, in particular, aggressively promoted development of new applications research for its remote-sensing data.

Despite the rapid growth of remote-sensing applications, advances were slowed by several circumstances (though some of these are about to change). First, improvements in remote-sensing applications led the federal government to commercialize LANDSAT in 1984. Unfortunately, LANDSAT commercialization proved premature and constrained state, local, and private sector use because of increased data costs. Commercialization proved unsuccessful, and, in 1992, the government resumed funding support of LANDSAT. NOAA will launch a new government-owned LANDSAT early next year.[8] Second, progress in civil use of classified satellite imagery, initiated over 30 years ago, has been exceedingly slow and severely constrained by security considerations. But, the results of the Government Applications Task Force, the Clinton Administration's commercial satellite imagery policy, and relaxing security controls likely will promote much greater civil use of remote-sensing data.

In the late 1980s, major improvements in global positioning resulting from the introduction of GPS satellites by DoD generated a new spurt of application technologies. The ability of on-the-ground researchers to collect and record data that could be accurately geo-located through post-processing techniques fostered new data collection and application technologies. The near-simultaneous development of hand-held computing devices significantly improved and expanded GI collection, recordation, and analysis. As GPS processing techniques continue to improve, these capabilities have been moving from researchers' desktops to accurate on-the-fly data collection and manipulation.[9]

During the coming decade, improvements in the quality and quantity of satellite remote-sensing data, advances in on-the-ground geo-locational technologies, and computer and communications capacities are clearly foreseeable and promise ever-expanding data collection and integration capabilities.

- NASA, for example, is fostering new applications research for uses of its prospective EOS sensors. In cooperation with private companies, NASA is planning to spend $20 million per year in 1997 and 1998 on these efforts.[10]
- NIMA has a substantial R&D budget to fund GI technologies, though the research is military-oriented. In addition, the intelligence community is spending significant funds to develop unclassified imagery-derived products that can be more widely used.
- USGS spends about $15-20 million annually on R&D, primarily to explore new applications of satellite imaging of interest to civil government activities and acts as the lead civil agency to facilitate civil government use of classified national security imagery.
- Private sector firms such as ETAK, DeLorme, Mapinfo, Autodesk, and others are pursuing new commercial applications of these technologies, particularly in transportation and vehicle navigation. Advanced applications to precision farming, commercial aviation, recreational boating, and a host of other uses appear highly likely.

Unfortunately, NASA, NIMA, and National Reconnaissance Office technology developments in GI-related areas are not well-coordinated with civil governmental needs. Their individual R&D programs are not integrated with those of NSF and USGS. Other GI agencies, such as BLM, Forest Service, and NOS, have very limited R&D funding for GI technologies[11] and very little influence on the research programs of the other agencies. Very limited research has been performed on GI technologies that are applicable to civil functions at multiple governmental levels or on the value of GI to civil governments.[12]

Computer Hardware and Software

The rapid development and widespread use of personal computers – desktop, portable, and hand-held – continue to revolutionize many information tasks and have already substantially eased the collection and integration of GI and improved its quality and quantity. Increased memory capacities, manipulation capabilities, media storage advances, software improvements, and visualization approaches have greatly facilitated new GI technologies. Most of these developments have occurred in the private sector, with the government providing some support for military and intelligence applications.

The Panel's purpose here is not to predict the likely direction of further computer hardware and software advances; other studies and more competent authorities lay out the likely continued growth and development of these technologies.[13] We know of no reason to dispute these trends, and the GI community, whether within government or the private sector, should continue to take these into consideration in planning the future.

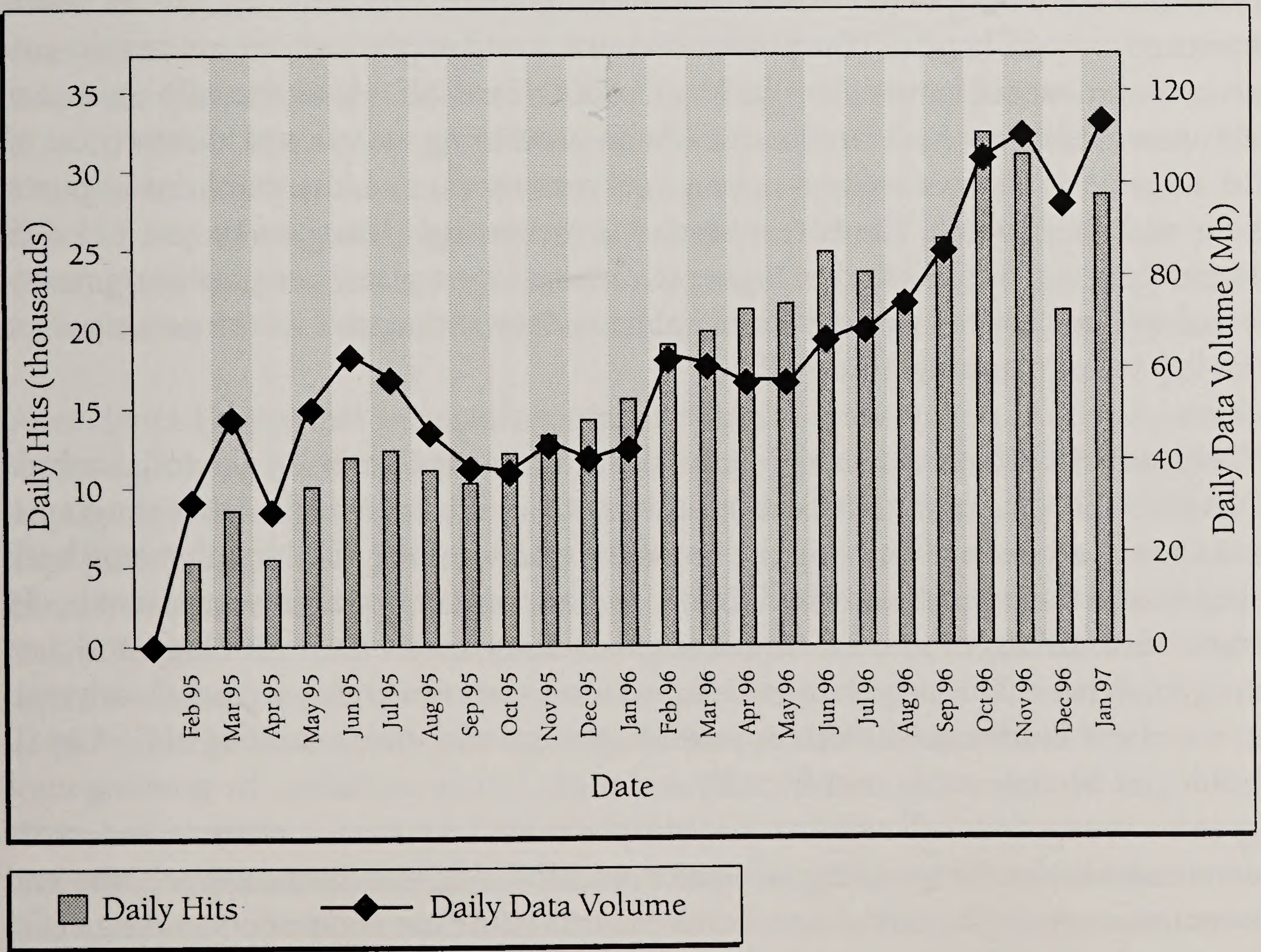
One area of computer software that is particularly relevant to GI is the development of standards covering the content and exchange of GI. These standards grow in importance as the capabilities and capacities of computer devices and telecommunications improve. It is increasingly easy to integrate, compare, and manipulate multiple geographic data sets, but this puts a premium on agreement on data content, format, and transmission standards. The FGDC is actively pursuing consensus agreement on these, but, as noted in Chapter Four above, the process is cumbersome and progress has been slow. Agreement on data content standards, in particular, has been very time-consuming.

However, the private sector also is actively engaged in solving the problem of data compatibility and integration for GI. OGC, a conglomerate of the leading hardware and software companies involved in GI, has embarked on a course that promises interface software to facilitate the communication and integration of GI. Several government agencies, including NIMA and FGDC, are involved in OGC's efforts, and the number of hardware and software vendors and apparent progress to date appear to bode well for this effort.[14] It is too early to predict success with confidence, but success would greatly ease data transfer and integration.

Communications and the Internet

The increasing availability of wide-band communications and the spread of the Internet are serving to accelerate the communication and exchange of ever-larger volumes of data. USGS's EROS Data Center, for example, has rapidly expanded its telecommunications capability to 20 very large capacity (T-1) lines and is now electronically distributing key geographic data layers, such as DEMs and DLGs. Figure 7-1 shows the explosive growth in the use of USGS's National Mapping Division World Wide Web site.

FIGURE 7-1: INCREASING USE OF THE US GEOLOGICAL SURVEY NATIONAL MAPPING DIVISION'S WORLD WIDE WEB SERVER



Interestingly, over 60 percent of its users are commercial firms, with federal agencies accounting for about 20 percent and state and local governments less than 5 percent. Some other types of base cartographic data, such as digital DOQs and DRGs also are expanding rapidly, although these are distributed in CD-ROM form today (and, therefore, not reflected above) because of bandwidth limitations.

Telecommunications specialists confidently predict that bandwidth limitations on data transfer that currently constrain electronic dissemination will soon be a thing of the past. Many of the data sets currently receiving only limited distribution in less convenient media, such as digital data tapes and CD-ROMs, are likely to transition to electronic dissemination. More sophisticated browsers that help users search and refine their data requests are facilitating this process. The EROS Data Center has developed advanced browsing techniques that allow users to preview scenes, for example. Internet accessibility is likely to continue to diminish the importance of the paper map. In the meantime, USGS is pursuing research into cost-effective, on-demand printing that would reduce the substantial printing and warehousing costs associated with the current process of paper-product distribution.[15]

Telecommunications developments are also increasingly satisfying mobility requirements with digital wireless technologies. These are likely to both expand the volume and improve the quality of on-the-fly data collection, data integration, and utilization. Digital wireless communications will improve the efficiency and accurateness of the collection, provide feedback to field data collectors, and facilitate more timely field analysis. The benefits of mobile communications are likely to grow in importance as field data collection processes become more automated.

Education and Training

Education and training of (1) private-sector and government personnel in the development and use of GI and (2) the public in its utility and application are among the priority development objectives identified by the FGDC and NSF. User-friendly computer hardware and software have been successful in promoting the use and effectiveness of GI in informing decision-makers, operators personnel, and the public-at-large on options and alternatives. The Forest Service is increasingly using its Project 615 GIS system to generate options in developing mandated forest plans; geographic representation of optional approaches facilitates public understanding and citizen participation in this key forest planning process.[16]

NSF supports UCGIS and has also funded the National Center for GI and Analysis (NCGIA). NCGIA, a consortium of three universities with leading GI science programs, has been very active in promoting the use and understanding of GI in informing both the public and the private sectors.[17] UCGIS is a nonprofit organization representing 34 academic institutions devoted to improving the theory, methods, technology, and data in the geosciences. The latter have developed a ten-part research program closely tied to its members' academic interests to promote the use and understanding of GI.[18] As GI technologies become more user-friendly and more widely available, the growing need for public interaction will need to be complemented by more coherent and more understandable data. Expanding education and training in community colleges and universities, support for curriculum developments in the use and understanding of GI, and selected research projects that demonstrate the utility and performance improvements resulting from the use of GI add important support to this process of education and training.

The acceptance, utilization, and utility of GI techniques will, the Panel believes, continue to expand rapidly. Educational and academic programs to support these ends and technical training to facilitate these are important and likely to continue to receive emphasis.

Implications of Trends for Government R&D

Federal government leadership in remote sensing, global positioning, and satellite technologies is likely to continue. The expense and risk of commercial space ventures, demonstrated by the aborted effort to commercialize LANDSAT, reinforce the government's long-standing dominance in advanced sensor techniques. Certainly in national security imaging and sensing, the U.S. government will remain the cutting-edge participant in new technology developments applicable to these missions. As these missions continue to evolve in the post-Cold War era, there is likely to be increasing intelligence community involvement in areas such as global disaster information and environmental monitoring. The need to coordinate national security, civil, and commercial interests closely to avoid bureaucratic conflicts and to promote maximum utility of expensive space assets will correspondingly increase.

Similarly, in the civil arena, specialized experimental developments of new sensing and imaging technologies, from both satellites and aircraft, will probably continue to require the support of the federal government. Developing new satellite-sensing technologies may well remain beyond the financial means of both sub-national governments and the private sector. However, the private sector's capabilities for development in this area are growing. The successful implementation of the government's policy on commercial imagery satellites that permits resolutions to the one-meter level opens the door for this development. Almost all of the commercial imaging companies are particularly interested in promoting value-added services in conjunction with their imminent delivery of satellite imagery. This is likely to generate some discord with NASA's announced Mission to Planet Earth Commercial Strategy, which aims to aid commercial firms in developing new applications of its imagery.[19] The nascent commercial satellite imaging industry could force NASA to limit its remote-sensing activities to clearly scientific and experimental efforts and to avoid long-term commitments to satellite activities that could encroach on private-sector operations.

As evidenced by the increasing internationalization of space station developments, there is also a growing need to consider the implications of foreign remote sensing and imaging capabilities and to avoid duplication in both data collection and processing of their capabilities. Except for SPOT, which has been heavily marketed in the United States, there seems to be little appreciation of, or utilization of, these foreign-developed systems in U.S. GI activities, and international coordination is not a strength of the domestic GI agencies. Where appropriate, an improving mechanism appears to be needed that takes account and better integrates foreign capabilities for earth observation.

The private sector has a clear, demonstrable lead in other technologies involving GI, including applications research, computer technologies, and telecommunications. In many areas of computer and telecommunications technologies, the government has not played, and probably will not need to play, a leading role. These areas are well-suited to private sector development and investment. Government's role, it appears, should not be competitive, but selective and focus on GI initiatives where the risk of failure is so high, or the opportunity for commercial profit is so limited, as to discourage private sector investment. These include:

- basic science where the prospect of commercial gain is either remote or non-existent
- selected applications research where the prospect of commercial gain does not cover the cost. However, this is an evolving calculus as the cost of data and processing decline; research geared to potential commercial applications may well be within the capability of an increasing number of established and/or venture capital companies.
- research on applications unique to government responsibilities. Much of USGS's limited research budget is devoted to specific government needs, such as famine warning, forest fire and volcano alerts, and Mojave desert protection.

A recent study of federal mapping research needs by Ohio State University's highly respected Center for Mapping found that budget reductions had substantially curtailed mapping research. Most agencies also share common problems regarding data acquisition and integration. The study recommended that the FGDC facilitate a joint research program in line with E.O. 12906's charge for the FGDC to "promote technology developments, transfer, and exchange."[20]

NASA, in response to congressional guidance, favors commercial-related research rather than partnerships with governmental entities at the federal, state, and local levels.[21] The agency has initiated some programs of interest to regional and local governments, but it primarily partners with private-sector companies. Most of its extensive research budget to promote the utility of Mission to Planet Earth[22] data is directed to private sector and long-run commercial operations, including commercialization of some current government functions. As noted above, this could fuel increased conflict between NASA and the private sector on applications research in the long term.

The federal government's approach to GI collection, geospatial analyses, and GI technology research is considerably more diffuse and disjointed than the research efforts associated with the government's formal global change research program, high-performance computing, and other dedicated research and development efforts. A consolidated, cross-cutting approach could coordinate the multiple national security and civil government priorities and take account of commercial and international developments affecting GI. Balancing collection, applications, academic, computer, and telecommunications developments would be challenging, but it is clearly impossible in the absence of a national forum. This task could be a component of the federal government's $1.9 billion Global Change Research Program, an effort to which many GI activities contribute.[23] Alternatively, a dedicated FGDC focus on interagency R&D is another possible approach. Either would require strong coordination and consultation with the NSDC, as recommended in Chapter Four.

The government also has a role, though not necessarily unique, in the development of standards. As the American economy has witnessed in the computer software industry, however, there is often sufficient public and commercial interest in promoting interoperability that government intervention that sustains multiple vendors may be both unwelcome and counterproductive. Future standards developments in areas such as communications interoperability and data exchange may be in this category. It may be more productive for the private sector to resolve their differences, either by agreement or in the marketplace.

This does not seem to be true in the area of data content standards, where the private sector often lacks the professional expertise and the interest in making precise scientific determinations. Even here, however, private software companies may be willing to enter the fray for the sake of commercial market advantage. At a minimum, the federal government has to be sensitive to the synergy between data content standards and software approaches. An active dialogue is being promoted by the OGC with significant NIMA and FGDC participation.[24]

Finally, NSF supports university research into curriculum development, selective geoscience research, and scientific and technical applications research. More support by a growing GI industry may eventually be forthcoming that would allow federal government support to be curtailed. Commercial and community understanding of the utility and contribution of GI to political decisionmaking and citizen participation also should be fostered.

Conclusions

The Panel concluded that the private sector will almost certainly continue to maintain its lead in GI technologies through advances in supporting computer, communications, and processing technologies. Further, the Panel found that the administration's policy promoting commercial satellite imagery appears to be constructively stimulating increased private sector research into imagery applications, primarily for private-sector needs, but also with potential use in support of civil government missions.

With respect to government R&D, the Panel concluded that satellite, remote sensing, and GI technology developments being pursued by NASA, NIMA, DoD, and the intelligence community need to take into account the potential applications of this research to civil government use. Though civil agencies have a more active role in classified imagery activities than in the past, USGS, NOS, BLM, Forest Service, and other agencies with civil missions need a stronger voice and role in satellite imagery and remote-sensing programs, including new technology developments, with significant applicability to civil government uses. The Panel concluded that the FGDC could usefully serve as a key forum to accomplish better interagency coordination

Recommendations

- **The technology development programs of civil agencies involved in GI should focus on civil government applications and basic science support. Federal government agencies should utilize, and not attempt to compete with, private-sector leadership in many areas of technology development applicable to GI.**
- **NIMA and NASA should ensure that FGDC members are made fully cognizant of technological developments applicable to civil government needs. To further civil government applications, the technology development**

programs of NIMA, the National Reconnaissance Office, and NASA should be coordinated and undertaken jointly, whenever possible, with civil agencies.

- **The FGDC should act as the focal point for coordinating the high-priority GI technology needs of civil government at all levels and for mobilizing interagency, state, and local support for selective high-payoff technology developments with utility in multiple civil applications.**

DOMESTIC-NATIONAL SECURITY RELATIONS

Product Cooperation

USGS and NOS focus on civil mapping of the U.S. land area and of coastal and U.S. jurisdictional waters. NIMA, formerly the DMA, is responsible for mapping in support of U.S. military and other international activities. Thus, these three agencies have similar missions with different geographic areas of interest. Nonetheless, the DoD has significant needs for map products of the United States of its domestic military installations and for land, sea, and air training and operations. The civil agencies, in contrast, have little demand for most international map products. For the most part, the relationship among the three agencies is characterized by strong cooperation with respect to products covering the United States. These include:

- **Topographic maps:** DoD and USGS use different scales for their basic topographic maps. Military training and operations worldwide are standardized on 1:50,000 topographic maps, whereas USGS's standard topographic map scale in the coterminous 48 states is 1:24,000. Nonetheless, USGS is able to use almost all of its standard map output to generate maps at the appropriate DoD scale, and DoD uses these products widely for domestic training activities.
- **Aeronautical charts:** As with topographic maps, DoD utilizes standard NOS products throughout its operations in the United States; additional data to conform to military standards and to include military airfields are sometimes added by DoD to the NOS inputs.
- **Nautical charts:** DoD has historically relied on NOS's nautical charts of U.S. coastal waters for approximately 500 of the 900 charts of U.S. coastal waters that DoD needs. Until 1998, DoD funded NOS's efforts to create a digital nautical chart in DoD's favored vector product format (VPF) that is compatible with its worldwide digital nautical chart and better accommodates sea-to-land operations. But, NOS experienced technical difficulties in creating this product, and DoD is now producing the VPF charts it needs.[25] NOS was also concerned that the differences in accuracy between its digital raster product, developed according to International Hydrographic Organization standards, and VPF format would be confusing for mariners.[26]

All products that DoD uses from these agencies are reimbursed based on the cost of reproduction.

In addition to product coordination, NIMA and the two civil agencies work cooperatively on distribution of NIMA products. USGS distributes NIMA (DMA) topographic maps through its nationwide outlets; in addition to distribution of its own products, NOS distributes DoD's worldwide aeronautical and nautical chart products. Both agencies are reimbursed by NIMA for their distribution costs.

Civil Use of Classified Imagery

There are varying degrees of cooperation by NIMA and other DoD agencies on other aspects of GI with civil agencies. Most noteworthy among them is a long-standing 30-year program to utilize classified intelligence imagery to meet civil needs. USGS chairs a Civil Applications Committee (CAC) composed of a large number of civil and defense representatives. The committee reviews and aggregates requests for satellite imagery – past, present, and future – for non-intelligence purposes to determine the priority, type, and quality of imagery required. These are referred to NIMA for legal and requirement reviews. Since intelligence needs rarely compete for collection over the United States, target competition is not a major impediment during NIMA's requirement review. But NIMA is particularly concerned that imagery will be used for law enforcement or internal security purposes, uses that it considers to violate the prohibition in law against CIA's involvement in these activities. Since high-resolution imagery of use to civil agencies might indeed reveal illegal activities, NIMA takes extraordinary steps to avoid this prospect.[27]

USGS also operates an Advanced Systems Center where it and other civil agencies can process, review, and manipulate classified satellite imagery. This imagery remains highly classified, and it is extremely difficult to use the imagery or the data from it outside of the classified environment. Since almost all civil agencies, particularly their field components, operate largely in an open, unclassified manner, data utilization is severely impeded. NOAA's Coastal Services Center in Charleston SC recently received approval for a secure data facility which will be utilized to process classified data. And, the intelligence community has an ongoing research effort to develop imagery-derived products that can be used outside classified facilities. Some agency representatives believe the process has been streamlined greatly in the last five years, allowing increased use for operational support of fire-fighting and emergency management. But most field personnel resent their lack of access to date, and they believe it indispensable to performance of their mission. Forest Service told project staff that it is highly unlikely that satellite imagery is indispensable to meet the needs of the field. This is reminiscent of the pre-Gulf War debates over distribution of highly classified satellite imagery to field commanders, an issue clearly resolved after that war in favor of widespread, nearly-instantaneous dissemination of imagery. Even declassified imagery is often restricted to the extent that state officials do not have access because it is restricted to federal "government official use only." Thus, the vast majority of federal field, state, and local officials have no access to classified or derived data without sponsorship. The high costs of personnel and physical security, as well as the expense of equipment to utilize classified imagery, effectively deters this approach.[28]

Other Areas of Potential Coordination

Security Policy: The CAC is a technical review committee that is ill-suited to resolve critical security policy concerns with the intelligence community. Fortunately, then-Senator Al Gore added funds to the intelligence community budget in 1990 to initiate the process of determining the value of satellite imagery in global change and environmental research. The Government Applications Task Force found that there were major scientific and monitoring tasks that could be performed with classified imagery.

Vice President Gore has remained a champion of these ongoing investigations, and the director of central intelligence recently established an Environmental Intelligence Center to help coordinate community efforts in these areas. Nonetheless, there remains a fundamental dichotomy between the administration's strong support for NSDI and classification policies that effectively stymie access by federal field, state, and local governments, and many private-sector firms to classified imagery, a major source of critical GI.

Procurement Activities: Considerable differences exist between the often classified, national security procurement process of intelligence community activities, such as NIMA, and those of most civil agencies. The intelligence community relies often on streamlined procedures that delegate significant day-to-day operational control to its contractors; civil agencies tend to look to contractors for specific equipment or limited services. NIMA and the FGDC have, for example, taken different approaches to their similar foreign and domestic GI needs. During this study, DoD initiated a new approach to have mapping services placed on an open GSA schedule. Civil agencies were not, however, involved in the original proposal and were briefed much later on the proposal. Greater integration of procurement policies and actions should be sought in the future.[29]

International Relationships: DoD has its own set of international ties geared specifically to its military alliances, NATO and other mutual defense or treaty arrangements. These relationships often include agreements on mapping and sharing GI, most of which require agreement on standards and presentation. Thus, NIMA has evolved de facto international "military" standards for mapping with a large number of allied countries. (Though representing a larger geographic community, a NIMA staff member also happens to be the United States representative to the International Standards Organization's ISO/TC211 committee dealing with GI.) NIMA's international military and U.S. domestic standards are often dissimilar, but most, like the standard 1:50,000 military topographic map, are readily convertible to other formats as with the USGS 1:24,000. Others, like the digital nautical chart in VPF format, are less easily and less accurately convertible to other "civil" international standards, such as those endorsed by the International Hydrographic Organization (IHO). For countries that cannot afford the comparative luxury of dual military and civil mapping organizations, there is the obvious potential for conflict between civil and military standards. As international standards grow in importance, it will be advantageous that the links between these standards are explicitly considered and, whenever possible, reconciled.

Research and Development: As discussed above in the technology section, GI technology research also need to be coordinated with respect to potential civil applications; DoD has one of the larger GI R&D programs and should be a major participant in a FGDC-led coordination.

Conclusions and Recommendations

The Panel found that the generally strong domestic-national security relationship on map production, processing, and product dissemination is in sharp contrast to poorer cooperation and coordination in management activities. Economic globalization, policy changes on commercial satellite imagery and security, government reinvention, and shifts in the nation's priorities from Cold War containment to enlargement and engagement, the Panel concluded, increasingly require greater domestic-national security interaction and cooperation. The Panel also concluded that the increased civil use of classified satellite imagery has been hampered by security, legal, technical, procedural, and bureaucratic barriers. Outside influences, including the Vice President, but not the CAC, have been the catalysts for change, and CAC membership does not appear to be at a level commensurate with these larger challenges.

Recommendations

- **NIMA should become much more actively engaged in the FGDC because of the increasing need to coordinate GI activities, including technological research, standards, security policy, procurement practices, and international activities.**
- **A policy-level committee that includes the secretary of the interior, the directors of NIMA and the National Reconnaissance Office, a representative of the director of central intelligence, and other appropriate representatives should be established to focus on policies needed to foster greater civil use of classified imagery.**
- **The CAC, supported by USGS's Advanced Systems Center, should become the technical and implementing arm of this committee.**

ENDNOTES

[1] Central Intelligence Agency, *Corona: America's First Satellite Program,* edited by Kevin Ruffner (Washington, DC: CIA, 1995).

[2] Tom Holm and Bill Draeger, USGS EROS Data Center, June 13, 1997 (interview).

[3] *Corona, op. cit.*, p. 37

[4] Tom Holm and Bill Draeger, USGS EROS Data Center, June 13, 1997 (interview).

[5] University of Nottingham, www.geog.nott.ac.uk/remote/faq-sata.html. August 1, 1997.

[6] National Academy of Public Administration, *The Global Positioning System: Charting the Future.* (Washington, DC: National Academy of Public Administration, 1995).

[7] Tom Holm and Bill Draeger, USGS EROS Data Center, June 13, 1997 (interview).

[8] See Remote Sensing Commercialization Act of 1984 and Remote Sensing Policy Act of 1992. Also, NASA, www.ls7pm3.gsfc.nasa.gov. August 1, 1997.

[9] National Academy of Public Administration, *The Global Positioning System: Charting the Future, op. cit.*, pp. 27–29.

[10] Michael Mann, NASA, December 6, 1996 (interview).

[11] Agencies' responses to NAPA data request, April, 1997.

[12] Paula Stevenson and John Bossler, *An Ad Hoc Review of Research Needs of Select Federal Mapping Agencies* (Ohio State University Center for Mapping, May 15, 1997).

[13] See INTEL co-founder Gordon Moore's law which, in 1965, predicted that transistor density on microprocessors doubles every two years.

[14] OpenGIS Newsletter, Vol. 1, No. 1, October 1996.

[15] Randle Olsen, USGS Rocky Mountain Mapping Center, November 13, 1996, and Bill Draeger, USGS EROS Data Center, June 13, 1997 (interviews).

[16] Steve Werner, Forest Service's GIS Center of Excellence, Ogden, Utah, January 15, 1997 and John Day, Forest Service Region 10, Tongass Forest, June 24, 1997 (interviews).

[17] University of California Santa Barbara, www.ncgia.ucsb.edu/varensius/jec.html. June 10, 1997.

[18] University of California Santa Barbara, www.ncgia.ucsb.edu/other/ucgis/CAGIS.html. May 19, 1997.

[19] NASA, Mission to Planet Earth Commercial Strategy, www.hq.nasa.gov/office/mtpe/comm_strat. May 19, 1997.

[20] William Clinton, E. O. 12906, Federal Register 59, April, 1994, and Paula Stevenson and John Bossler, *An Ad Hoc Review of Research Needs of Select Federal Mapping Agencies, op. cit.*

[21] Dan Goldin and Michael Mann, NASA/Industry Workshop on MTPE's Commercial Strategy, July 22–23, 1996, and Lawrence Freidl, *Implications of NASA's Commercial Strategy for Earth Observing Data* (Harvard University, Kennedy School of Government, Policy Analysis Exercise, April 9, 1996).

[22] NASA's Mission to Planet Earth (MTPE) is a major NASA component focused on earth observation and measurement that includes NASA's LANDSAT, EOS, and other earth-oriented projects.

[23] Global Change Research Information Office, www.gcrio.org/ocp98/appendixA.html. June 12,1997.

[24] OpenGIS Newsletter, Vol. 1, No. 1, October 1996.

[25] National Research Council, *Technical Issues in NOAA's Nautical Chart Program* (Washington, DC: National Research Council, 1996). Also see National Academy of Public Administration, *A Performance Based Organization for Nautical Charting and Geodesy* (Washington DC: National Academy of Public Administration, 1997).

[26] Bill Hogan, NIMA, response to information request, April 4, 1997.

[27] Karen Irby, USGS Advanced System Center, June, 1997 and Dave Schultz, NIMA, January 10, 1997 (interviews).

[28] Mark Shasby, USGS and Chair, Alaska Geographic Data Committee, June 25, 1997; Dave Schultz, NIMA, *op. cit.*, and Eric Anderson, USGS and Chair, CAC, March 7, 1997 (interviews).

[29] Clay Ansell, NIMA, January 10, 1997 and Kathy Clement, USGS, May 28, 1997 (interviews).

ACRONYMS

Association of American State Geologists	AASG
Australian Bureau of Statistics	ABS
Office of Aeronautical Charting and Cartography	AC&C
Army Corps of Engineers	ACE
Advisory Commission on Intergovernmental Relations	ACIR
Australian Center for Remote Sensing	ACRES
American Congress on Surveying and Mapping	ACSM
Association for Geographic Information	AGI
American Geological Institute	AGI
Australian Land Information Council	ALIC
Automated Mapping/Facilities Management	AM/FM
American National Standards	ANS
American National Standards Institute	ANSI
Application Processing Interface	API
American Standard Code for Information Interchange	ASCII
American Society for Photogrammetry and Remote Sensing	ASPRS
Australian Survey and Land Information Group	AUSLIG
Bureau of Indian Affairs	BIA
Bureau of Land Management	BLM
Civil Applications Committee	CAC
Canadian Active Control System	CACS
Computer Aided Design	CAD
Computer Aided Design and Drafting	CADD
Canadian Base Network	CBN
Competitive Cooperative Agreements Program	CCAP
European Committee for Standardization	CEN
Council on Environmental Quality	CEQ
Cartographic Feature File	CFF

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Jim Stapleton	Assistant Regional Engineer
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Geographic Survey Institute (Japan)	GSI
Inter-agency Committee on Geomatics	IACG
Institute for Applied Geodesy (Germany)	IAG
International Cartographic Association	ICA
International City-County Management Association	ICMA
Intergovernmental Committee of Surveying and Mapping	ICSM
Institut Geographique National (France)	IGN
International Hydrographic Organization	IHO
Information Infrastructure Standards Panel	IISP
Integrated Product Team	IPT
Interorganizational Resource Information Coordinating Council	IRICC
International Organization of Standardization, Technical Committee 211	ISO/TC211
International Society for Photogrammetry and Remote Sensing	ISPRS
Information technology	IT
Information Technology Management Reform Act of 1996	ITMRA
Intelligent Transportation Systems of America	ITSA
Land Information System	LIS
Management Association for Private Photogrammetric Surveyors	MAPPS
Memoranda of Understanding	MOU
Metropolitan Planning Organization	MPO
Mapping Sciences Committee	MSC
National Association of Counties	NACo
National Academy of Public Administration	NAPA
National Aerial Photography Program	NAPP
National Association of Regional Councils	NARC
National Aeronautics and Space Administration	NASA
North Atlantic Treaty Organization	NATO
National Center for Geographic Information and Analysis	NCGIA
National Cooperative Geological Mapping Program	NCGMP
National Committee for Information Technology Standards	NCITS
National Environmental Data Index	NEDI
National Governors' Association	NGA
National Geodetic Survey (of NOS)	NGS
National Institute of Building Services	NIBS
National Environmental Data Index	NEDI
National Information Infrastructure	NII
National Imagery and Mapping Agency	NIMA
National Interest in Mapping Service Agreement	NIMSA
National Institute of Standards and Technology	NIST
National League of Cities	NLC
National Land Survey (Sweden)	NLS
National Mapping Division	NMD

National Mapping Program	**NMP**
National Oceanic and Atmospheric Administration	**NOAA**
National Ocean Service	**NOS**
National Performance Review	**NPR**
National Park Service	**NPS**
National Research Council	**NRC**
Natural Resources Canada	**NRC**
National Resources Conservation Service	**NRCS**
National Spatial Data Council	**NSDC**
National Spatial Data Infrastructure	**NSDI**
National Science Foundation	**NSF**
National States Geographic Information Council	**NSGIC**
National Spatial Reference System	**NSRS**
National Watershed Assessment Project	**NWAP**
Office of Coast Survey	**OCS**
Open GIS Consortium	**OGC**
Office of Management and Budget	**OMB**
Ordnance Survey (UK)	**OS**
President's Council on Sustainable Development	**PCSD**
Payment in lieu of taxes	**PILT**
Public Land Survey System	**PLSS**
Research and development	**R&D**
Spatial Data Transfer Standard	**SDTS**
Statistiches Bodeninformationsystem (Germany)	**STABIS**
Svensk Fastighetsvordering (Swedish Real Estate Valuation Ltd.)	**SVEFA**
Standards Working Group	**SWG**
Technical Advisory Group	**TAG**
Topologically Integrated Geographic Encoding and Referencing	**TIGER**
Tennessee Valley Authority	**TVA**
University Consortium for Geographic Information Science	**UCGIS**
Urban and Regional Information Systems Association	**URISA**
United States Department of Agriculture	**USDA**
United States Geological Survey	**USGS**
World Geodetic System	**WGS**

GLOSSARY

aeronautical chart – a chart designed for use in aircraft navigation that shows airports, aids, hazards to navigation, and some natural and man-made features recognizable from the air.

attribute – a characteristic of a map feature or object. In mapping and GIS applications, the features or objects are points, lines, or polygons representing section corners (points), roads and streams (lines), lakes or forest and soil types (polygons). These attributes can be further divided by class such as tree species for forest type and paved and gravel for road type. Multiple attributes are generally associated with features or objects located on a single map layer.

Automated Mapping/Facilities Management – a GIS technology focused on geographic information applications and management of specialized infrastructure and facilities, such as factories, refineries, and utility networks.

base map – a map which shows the horizontal position of the features represented on which additional information may be placed.

bathymetry – the measurement and study of water depths.

cadastral – pertaining to extent, value, and ownership of land; cadastral maps show property boundaries and corners.

cadastre – an official register of the location, boundaries, ownership, value, and other attributes of real estate, compiled as a basis for taxation.

cadastre, multipurpose – an extension of the cadastral concept to include geodetic control, topographic base maps, and land information overlays with real estate files linked at the parcel level to boundaries, right-of-ways, easements, and supporting attribute records.

cartographic feature file – the digitized representation of all the point and line features shown on a Forest Service Primary Base Series map, with the exception of contours, vegetation, and text.

cartography – the science and art of making maps and charts; broadly, all the steps needed to produce a map: planning, aerial photography, field surveys, photogrammetry, editing, color separation, and multicolor printing.

clearinghouse – an agent or broker for the classification, cataloging, and dissemination of information.

devolution – process whereby functions performed by the federal government are turned over to state, county, local, or other governmental levels.

digital line graph – digital vector representation of the feature information portrayed on topographic maps.

digital elevation model – a digital file containing an array of regularly spaced elevations.

digital orthophoto quadrangle – an ortho-rectified digital image generated from digitized aerial or satellite photography.

digitize – to convert analog geographic information into a digital form using a digitizing tablet or an automated scanning device.

Federal Geographic Data Committee (FGDC) – a multi-agency committee established by the OMB to promote the coordinated development, use, sharing, and dissemination of geospatial data.

framework – seven priority layers designated by the FGDC that serve as foundational GI for the nation, including geodetic control, digital orthoimagery, elevation, transportation, hydrography, governmental boundaries, and cadastre.

geodesy – the science concerned with the measurement and mathematical description of the size and shape of the earth and its gravitational field.

geodetic control – a set of surveyed features with their location referenced to particular survey monuments by latitude, longitude, and height above the ellipsoid. These 'control points' are used to register the map to definitive positions on the earth's surface.

geographic information (GI) and cartographic information – information about objects found on the earth's surface, including their locations, shapes, and description.

geographic information system (GIS) – an organized collection of computer hardware, software and geographic data designed for the input, storage, retrieval, manipulation, and display of spatially referenced data.

geomatics – a term similar to geometronics (below) often used in Canada and Europe.

geometronics – the science of recording, measuring, interpreting, handling, and displaying information about the earth and its resources.

geospatial – pertaining to the geographic location and characters of natural or constructed features and boundaries on the earth.

Global Positioning System (GPS) – a system used to locate positions and points on the earth based on signals from several satellites.

ground survey – a survey made at ground level, as distinguished from an aerial survey, that provides coordinates of points on the ground and distances and/or angles between these points.

hydrography – the science dealing with the physical features of oceans, lakes, rivers, and other surface waters often conducted in support of marine navigation and nautical charting.

land information system – manual or computer-based systems used to establish, operate, maintain, and analyze facilities, resources and/or activities within a defined geographic area.

metadata – data that contains or defines other data. For geospatial purposes, metadata provides information about sources used, collection methods, vintage, datum, projection, etc.

nautical chart – charts used in conjunction with marine navigation

National Spatial Data Infrastructure (NSDI) – a national structure of policies, standards, technologies, and human resources that supports and facilitates the management and use of geographic information.

orthophotograph – an image reproduction prepared from a perspective photograph in which the displacement of features due to sensor tilt and terrain relief have been removed using rectification techniques.

photogrammetry – the science of obtaining reliable measurements or information from images.

privatization – commercialization where formerly governmental functions and full responsibilities are shifted from the government to the private sector; the government generally has no continuing role in financial support, management, regulation, or oversight for privatized activities.

quadrangle – a map or plot of a four-sided area, bounded by parallels of latitude and meridians of longitude.

raster data – a row of elements, such as pixels, represented as a regular two-dimensional arrangement of data values at discrete points, normally expressed line by line across a given surface or area.

remote sensing – imaging or recording of physical phenomenon, at a distance, by detecting emitted or reflected energy.

rectification – the process of removing displacement in a photograph caused by tilt and/or terrain relief.

spatial data – geographically referenced features that are described by geographic positions and attributes in an analog and/or computer-readable (digital) form.

surveying – the art and science of acquiring qualitative and quantitative information to determine the relative locations of points and features on or near the earth's surface.

TIGER (topologically integrated geographic encoding and referencing) – a database structure developed by the U.S. Bureau of the Census to support the 1990 census that contains census data such as street address ranges along lines and block boundaries.

topography – the form of the physical features of a land surface or sea bottom; also called relief.

APPENDIX A

Panel Members and Staff

PANEL MEMBERS

Edward E. David, Jr.,* *Chair* – President, EED, Inc.; former Science Advisor to the President; Director, Office of Science and Technology; Executive Director, Research, Bell Telephone Labs; Vice President, Exxon Corporation.

Gerald R. Riso,* *Co-Chair* – Management consultant, former Vice President, Booz Allen and Hamilton; Associate Director for Management, Office of Management and Budget; Assistant Secretary for Program/Budget Administration, U.S. Department of the Interior.

Eric A. Anderson* – City Manager, City of Des Moines, Iowa; former City Manager, City of Evanston, IN; City Manager, City of Eau Claire, WI; Town Manager, Munster, IN; Assistant Town Manager, Windsor, CN; Assistant Director, Research and Development, International City Management Association..

Jerry A. Aspland† – President, California Maritime Academy; Vice Chairman of the Marine Board, National Academy of Sciences; retired President, ARCO Marine, Inc.

Lawrence F. Ayers, Jr.† – Executive Vice President, Intergraph Corporation; former Civilian Director, Defense Mapping Agency; key participant in charter to consolidate the Army, Navy and Air Force assets into the Defense Mapping Agency.

Jack Dangermond† – President and CEO, Environmental Systems Research Institute, Inc., Redlands, CA.

Jonathan B. Howes* – Director of University Outreach, University of North Carolina at Chapel Hill; former Secretary, Department of Environment, Health and Natural

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* Academy Fellow.

† Not an Academy fellow; nominated by one or more of the sponsoring agencies.

Resources, State of North Carolina; former Research Professor and Director, Center for Urban and Regional Studies, University of North Carolina; Mayor, Town of Chapel Hill; Director, Urban Policy center, Urban America, Inc.

Bradford Huther* – Deputy Director, Bureau of the Census, Department of Commerce; former Associate Commissioner and Chief Financial Officer, Patent and Trademark Office, former Assistant Commissioner for Finance and Planning, Deputy Assistant Commissioner for Administration, Deputy Assistant Commissioner for Operations, Patent and Trademark Office

Terrence J. Keating† – Owner and President, Lucerne International, specializing in marketing and development issues; former owner and President, Kork Systems, Inc.

Lawrence J. Korb* – Director, Center for Public Policy Education, The Brookings Institution; Adjunct Professor, Georgetown University; former Assistant Secretary of Defense for Manpower, Installations and Logistics, U.S. Department of Defense.

Wendy Lathrop† – Manager of Geographic Search Services, Charles Jones, Inc.; registered professional land surveyor; President, National Society of Professional Surveyors.

STAFF

Arnold E. Donahue, *Project Co-Director.* President, Pactrade, Inc.; former Senior Executive Service, Chief, Command, Control, Communications and Intelligence, Office of Management and Budget; Intelligence officer and economist, Central Intelligence Agency.

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Robert Lee Chartrand, *Senior Research Associate.* Former Senior Specialist and Senior Fellow, Information Policy and Technology, Congressional Research Service. Former Advisor, U. S. Congress, AAAS fellow and received both the 1985 ASIS Award of Merit and the Library of Congress Award for Superior Service in 1988.

Patricia M. Durkin, *Editor.* Editorial consultant for the National Academy of Public Administration, National Geographic Society, Library of Congress, National Park Service, and other organizations.

Martha S. Ditmeyer, *Research Assistant.* Consultant, National Academy of Public Administration. Former staff member Massachusetts Institute of Technology; former staff member, Comsat.

Jeffrey Fitzpatrick, *Project Coordinator.* Research Associate, National Academy of Public Administration; former Policy Analyst, U.S. Advisory Commission on Intergovernmental Relations.

Michael B. Fraser, *Senior Research Associate.* Deputy Director, Center for Information Management. Team Leader, Innovation Fund, Vice President Gore's Task Force on Reinventing Government (NPR). Former Chief Data Management, NOAA Fisheries.

Emily K. Hage, *Research Assistant. Consultant,* National Academy of Public Administration; former Research Assistant, Economic Research Service, USDA.

Bruce D. McDowell, *Senior Research Associate.* Former Director of Government Policy Research and Assistant to the Executive Director, U.S. Advisory Commission on Intergovernmental Relations; Director of Governmental Studies, National Council on Public Works Improvement.

Rebecca Wallace, *Senior Research Associate.* Management Consultant, former Director of Logistics Management, U.S. Customs Service; Deputy Director, Office of Administrative and Publishing Services and Development Specialist and Evaluator of Intergovernmental Programs, General Accounting Office.

Lisa Warnecke, *Senior Research Associate.* Author of the *State Geographic Information Activities Compendium;* co-founder of the National States Geographic Information Council; principal investigator, *National Study of Information Resources Management in State Governments;* Town Manager in Colorado.

APPENDIX B

Agency Contacts

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Joseph Kuchler
Government Affairs Director
American Congress on Surveying and Mapping

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* Charles Schwarz, NOAA, National Geodetic Survey, also represented the agency during much of the project.

† Contracting officer's technical representative.

APPENDIX C

Issues, Other Analyses, and Underlying Assumptions

ISSUES

Policy Bases: Are the policy bases under which the federal government and individual agencies conduct their surveying, mapping, and GI activities adequate and relevant to current problems and technologies?

Leadership, Coordination and Standards: Do E.O. 12906 on the National Spatial Data Infrastructure & OMB Circular A-16 on operations of the Federal Geographic Data Committee provide sufficient policy and institutional bases for setting standards, integrating federal activities, and coordinating with other governmental and private sector activities?

Structure and Organization: Are there opportunities to consolidate major federal activities or otherwise share capabilities that could eliminate redundancies, significantly improve performance, and/or reduce costs?

Public Purpose: Which surveying, mapping, and GI activities serve fundamental public purposes and are inherently governmental functions? Which are inherently federal?

Outsourcing: Are there significant opportunities to contract out substantial additional portions of the federal government's surveying, mapping, and GI activities?

Intellectual Property Rights: What policy options are there to protect and/or monetize data rights that would enhance revenues for federal operations and/or motivate the private sector or other providers to perform greater portions of these activities?

Pricing: Would alternative pricing strategies and/or mechanisms for government products help to "clear the market," i.e., better balance federal government demands with federal government resources? What are they?

Partnerships: Are there significant opportunities for federal agencies to enter into additional partnership arrangements (with states, localities, academe, NGOs and/or private industry) to help better meet federal, state and local needs? What are they?

Technology: Are there major technological options that could significantly impact federal performance of geographic information missions that should be more aggressively pursued/funded?

Domestic/National Security Relationships: What national security and/or international considerations significantly influence civil surveying, mapping, and GI activities and how should they be accommodated?

OTHER ANALYSES

Economic Value: How important are these activities to the nation's global competitiveness? What are there most important uses on a national scale?

Historical Evolution: How have U.S. geographic activities evolved and how does this history impact current geographic missions and options?

Societal Changes: What non-technological changes in society are significantly impacting geographic information activities and how do they/should they influence the options being considered?

International Practices: How do international trends and the practices of other nations compare to those of the United States?

Best Practices: What exemplary practices exist in the surveying, mapping, and geographic information areas that should be emulated more widely?

UNDERLYING ASSUMPTIONS

To help guide the study research, the project staff developed a list of underlying assumptions about GI. The list, categorized by subject area, was extensively revised and refined based on staff research and analysis and panel deliberations.

Policy Assumptions

- Establishing the policies, procedures and standards that are to compose the NSDI is a worthwhile national goal; appropriate steps should be taken by all sectors, working together with federal leadership, to help establish and implement them.
- Governments, independently and collectively, have essential roles in the information age in data acquisition, coordination, clearinghouse management, standardization, quality assurance, development and maintenance of geospatial databases for the public good that cannot be achieved without an agreed-upon foundation; a diversity of additional data layers, so-called framework data, need to be maintained.

- Federal agencies, state and local governments, and the private sector all need reliable, timely and accurate geospatial data to perform essential tasks, but only the federal government has the authority and capacity to assure the provision of comprehensive framework data either directly or in partnership with third parties.
- When it is determined to be in the national interest, the United States should cooperate with other nations to create and maintain comprehensive, up-to-date and compatible base geographic data.
- Society benefits and decisionmaking improves if geospatial data produced by governments at all levels, either directly or through its contractors, to meet mission needs are available to the public free or at reasonable cost. Widely available data enhances citizens' capacities to participate in the democratic process.
- The federal government uses the private sector, as well as state and local governments, to meet its geospatial data needs where there is capacity to do so at competitive costs. As additional private sector capabilities become available at reasonable cost and timeliness, federal agencies seeks to take advantage of them even if one result is curtailing or dismantling existing governmental facilities over time. The extent of governments' reliance on the private sector depends in part on the need to retain in-house capacity for contracting and program management and the inherent or underlying public purposes being served.

Programmatic Assumptions

- Federal agencies require geospatial data to carry out their missions and programs, and they must acquire such data. If such data are not available from others, they have to produce it themselves or have it produced by others.
- The federal government and other sectors should work to maintain and enhance the U.S. competitive advantage in geospatial data.

Operational Assumptions

- There is a single set of land masses, including submerged lands and surrounding bodies of water, the geographic characteristics of which can be ascertained, recorded and distributed for numerous uses in a wide variety of formats and data tolerances.
- GPS navigation satellites and other technologies now make it possible to determine a precise position within one centimeter or less anywhere on Earth, but existing systems and practices haven't adjusted yet to take full advantage of this new capability.
- Federal agencies developing and producing geospatial data should work to share their capabilities with other agencies and not compete with the private sector or duplicate capabilities available from state and local governments.

APPENDIX D

Interview and Contact List

FEDERAL GOVERNMENT

Congress

Senate

Cherie A. Cooper	Committee on Appropriations, Subcommittee on Interior and Related Agencies
Virginia James	Committee on Appropriations, Subcommittee on Interior and Related Agencies

House of Representatives

William S. Condit	Committee on Resources, Subcommittee on Energy and Mineral Resources
Delacroix Davis	Committee on Appropriations, Subcommittee on Interior and Related Agencies
Joel Kaplan	Committee on Appropriations, Subcommittee on Interior and Related Agencies
Christopher Kearney	Committee on Resources, Subcommittee on Energy and Mineral Resources

General Accounting Office

David G. Gill	Assistant Director, Accounting and Information Management Division
Chester Joy	Resources, Community and Economic Development Division
Robert Reining	Accounting and Information Management Division

Library of Congress

William Ellis	Senior Specialist, Congressional Research Service
Gary L Fitzpatrick	GIS Specialist, Geography and Map Division

Daniel Mulhollan	Director, Congressional Research Service
Angela Owens	Deputy Director, Congressional Research Service

Executive Branch

Central and Coordinating Organizations

Council of Environmental Quality

Robert Cunningham	Associate Director

Federal Geographic Data Committee

Michael Domeratz	Staff, Framework
Bruce McKenzie	Staff, Cooperative Agreements
John Moeller	Staff Director

General Services Administration

Francis A. McDonough	Associate Administrator, Office of Policy, Planning & Evaluation

Office of Management and Budget (OMB)

Sharon Barlow	FAA Examiner
Janet Irwin	Acting Branch Chief, Interior Branch
Sarah Laskin	NOAA Examiner
William McLeod	NIMA Examiner
Gary Reisner	USGS Examiner

Office of Science and Technology Policy

Jeff Hofgard	Assistant Director for Aeronautics and Space
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Department of Agriculture

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APPENDIX E

Historical Evolution of the Federal Government's Needs and Programs for Geographic Information (GI)

INTRODUCTION

Governments are inherently territorial. That is, they are geographic jurisdictions with responsibilities for programs that benefit the peoples, lands, economies, and other enterprises within their borders. The relationship between government and geography is so strong that much of the business of government is often described as geopolitics. The centrality of territory to their missions makes governments highly dependent on geographic information (GI) and major sources of it.

The geographic basis of the United States government is acknowledged in the Constitution, which provides for:

- the members of the House of Representatives to be apportioned among the states according to the relative populations of each state, each member representing a congressional district of approximately equal population (Art. I, Sec. 2. This provision establishes the basis for the decennial census of population.)
- two senators from each state (Art. I, Sec. 3. This provision recognizes that geography is as important as population in governing fairly.)
- the establishment of post roads (Art. I, Sec. 7. Roads connect places.)
- federal judicial powers that extend to, among other matters, property disputes involving the federal government, two or more states, or citizens claiming lands under grants from different states (Art. III, Sec. 2)
- the power of the Congress to dispose of and make regulations for the governing of territories and other properties belonging to the U.S. government (Art. IV, Sec. 3)
- the guarantee to every state the integrity of its borders (Art. IV, Sec. 4)
- the guarantee of property rights of all persons (Amendments V and XIV)

Within this broad framework, the land-related and geography-related functions of the federal government have developed in many directions. The federal government is the holder of the original and subsequently created land records for much of the nation, the supplier of the nation's system of geodetic control and the Public Land Survey System (PLSS), as well as the authoritative nautical and aeronautical navigation charts. It also supplies many base maps and general purpose maps to both mapmakers and map-users; it is the source of many images of the earth taken from both airplanes and satellites; it is a developer of new technologies, such as lasers which have become important to the surveying community, and remote-imaging technologies (including both the satellite systems themselves and the growing range of sensors that are being placed in orbit; it produces nationwide databases of many types that have contributed essential elements to rapidly proliferating GI systems (GIS); and it is promoting a concept known as the National Spatial Data Infrastructure (NSDI) to encourage and facilitate the exchange and integration of many different sets of geographic data from all around the nation.

The purpose of this historical analysis is to describe how the federal government's GI agencies and programs have developed this rich array of functions, and how the federal programs relate to and interact with similar programs and institutions in the state, local, and private sectors. These developments provide an essential framework for understanding the current situations and issues faced by federal agencies having GI responsibilities.

To fulfill this purpose, this Appendix (1) summarizes the history of the four federal agencies sponsoring this study and indicates how GI contributes to the success of their missions, (2) overviews the history of the nation's public lands, (3) briefly describes the other major land-based federal programs, (4) recounts how the main building blocks of national GI resources have developed, and (5) chronicles the relatively recent development of national GI coordination efforts.

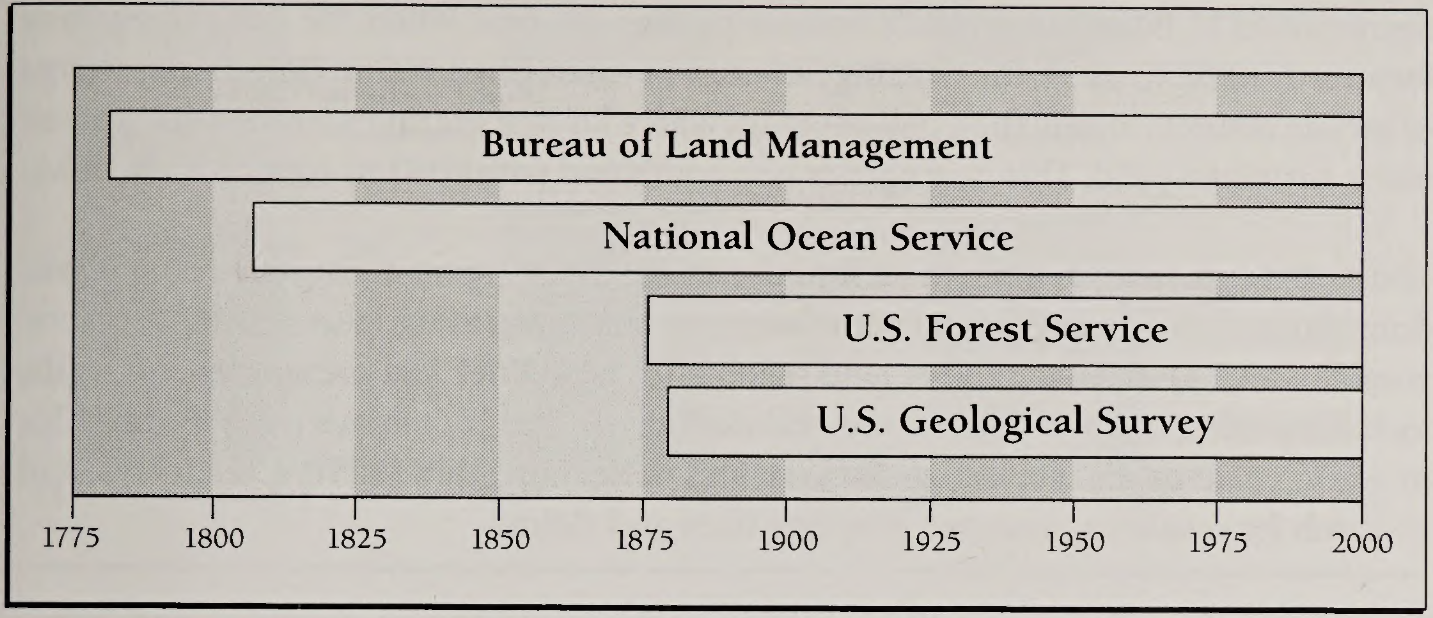
HISTORY OF THE FOUR SPONSORING FEDERAL AGENCIES

Although a very large number of federal agencies have GI roles and responsibilities, the four civilian agencies having the largest and most significant responsibilities for mapping, surveying, and supplying navigation charts are financing the National Academy of Public Administration (Academy) study. Other federal agencies will be mentioned later – along with lesser mentions of state, local and private institutions that play related roles. At this point, however, this analysis turns to the evolution of the four sponsoring federal agencies: the Bureau of Land Management (BLM), the U.S. Forest Service, the U.S. Geological Survey (USGS), and the National Ocean Service (NOS).

Figure E-1 shows the time periods over which these four federal agencies and their predecessors have existed. Later figures detail how three of these agencies have evolved over those periods. The two other largest federal land-owning agencies – the U.S. Fish and Wildlife Service (FWS) and the National Park Service (NPS) – have been established more recently (1903 and 1916, respectively) as the need to preserve certain lands for special purposes was recognized. These other two agencies, together with BLM and the Forest Service, account for most of the public lands currently being managed by the federal government. Management of those federally held public lands creates a very significant demand for surveying and mapping services that are described later in this paper.

Historical Evolution of the Federal Government's Needs and Programs for Geographic Information (GI)

FIGURE E-1: HISTORY OF THE FOUR SPONSORING AGENCIES



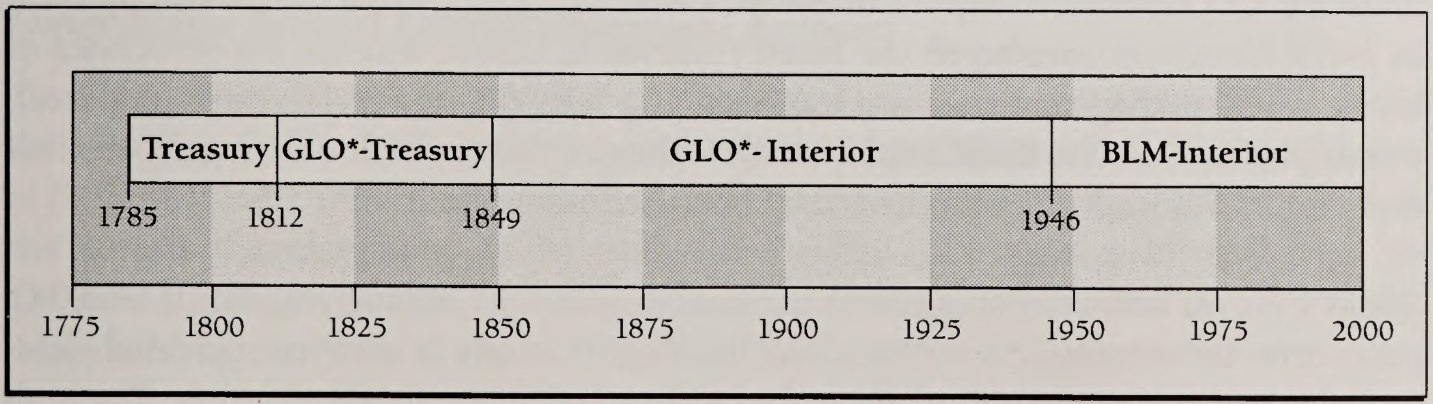
Bureau of Land Management[1]

BLM is the agency in the U.S. Department of the Interior (DOI) that manages all of the public domain lands of the United States government that have not been disposed of or reserved for specific purposes such as national forests, parks, and wildlife refuges. BLM's lands are largely located in the western states.

BLM's roots go back further in history than those of the other three agencies sponsoring this study. Its evolution is depicted in Figure E-2. BLM's roots began even before the U.S. government was formed, when the Board of Treasury under the Continental Congress was given responsibility for establishing the PLSS and selling public lands to raise money for the government. The first sale occurred in 1787, and other sales continued under the Department of the Treasury in the U.S. government after the Constitution was ratified.

The General Land Office (GLO) was established in the Treasury Department in 1812, and for the next 134 years it carried out broad responsibilities for surveying, accounting for, managing of, and disposing of the federal government's very large land holdings

FIGURE E-2: HISTORY OF THE BUREAU OF LAND MANAGEMENT



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*GLO = General Land Office.

ceded to it by the states when the nation was formed, plus the other large territories acquired at later stages in the nation's history. Early GLO surveys collected a great deal of information about the characteristics of the land, going well beyond the simple descriptions of boundaries. GLO became part of the DOI when the department was formed in 1849. In 1934, the Grazing Service was established within DOI to take charge of certain districts within the public domain where limited grazing was allowed to maintain a sustained yield. This new agency was combined with GLO in 1946 to form BLM.

Today, BLM carries out three main functions: (1) management of the remaining public domain lands, including leases for timber, minerals and grazing, plus permits for recreational uses, (2) management of land records for all former and present federal lands, including titles, leases, rights-of-way, and exchanges, and (3) maintenance of the PLSS, including placing and replacing markers, and performing new surveys, resurveys, and research for resolving disputed property lines and claims.

To support these functions, BLM obtains aerial photography, compiles and prints maps, and uses GIS. BLM also supplies many maps to recreational users of its lands. BLM's National Applied Resources Sciences Center in Denver is available to assist BLM's state offices. BLM's state offices are located where most of the responsibilities are carried out.

The programs to modernize BLM's Land Information System (LIS) and GIS capabilities have been delayed for lack of funding and personnel.[2] Priorities for installing GIS in BLM are left mostly to the discretion of BLM's state offices, and progress has been uneven, despite the national emphasis on using ecological management techniques that rely heavily on GIS support.

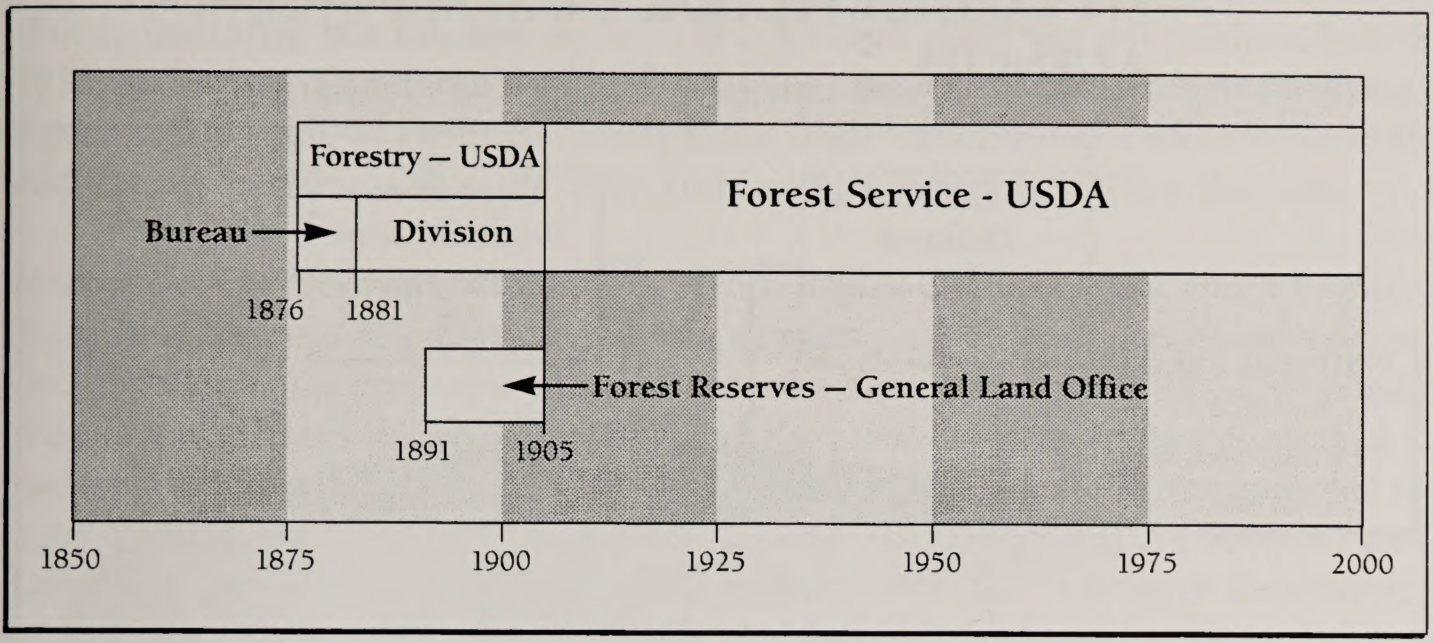
Liaisons which had been firmly established with USGS and the Forest Service are being reduced as budgets are cut. Liaisons with state and county officials are becoming increasingly important to the work of BLM's state offices as the GIS capabilities of subnational governments improve.

Forest Service[3]

The antecedents of the Forest Service began to appear with the establishment of the very small Bureau of Forestry under the Department of Agriculture (USDA) in 1876. The Bureau was expanded slightly in 1881 and renamed the Division of Forestry. However, when portions of the public domain were set aside as forest reserves in 1897, they were under the administrative control of the General Land Office, which had no foresters. GLO created a Division of Forestry which had acquired a staff of 400 by 1901. In 1905, Congress transferred the forest reserves to USDA, and the Forest Service of today, a land-management agency, was born. It is now the second-largest federal land-owning agency, next to BLM, but its land has the greatest recreational usage of any federal agency. Figure E-3 summarizes the Forest Service's evolution.

Today's Forest Service manages 155 national forests, 21 national grasslands, and 112 other units in 44 states, Puerto Rico, and the Virgin Islands. It uses the sustained-yield, multiple-use concept to both manage the land and serve the needs of people. The multiple uses accommodated on a sustained-yield basis are: recreation, fisheries, wilder-

FIGURE E-3: HISTORY OF THE U.S. FOREST SERVICE



ness, watershed protection, wildlife management, range management, timber management, soil conservation. energy and mineral resources, and protection of threatened and endangered species (plants and animals).

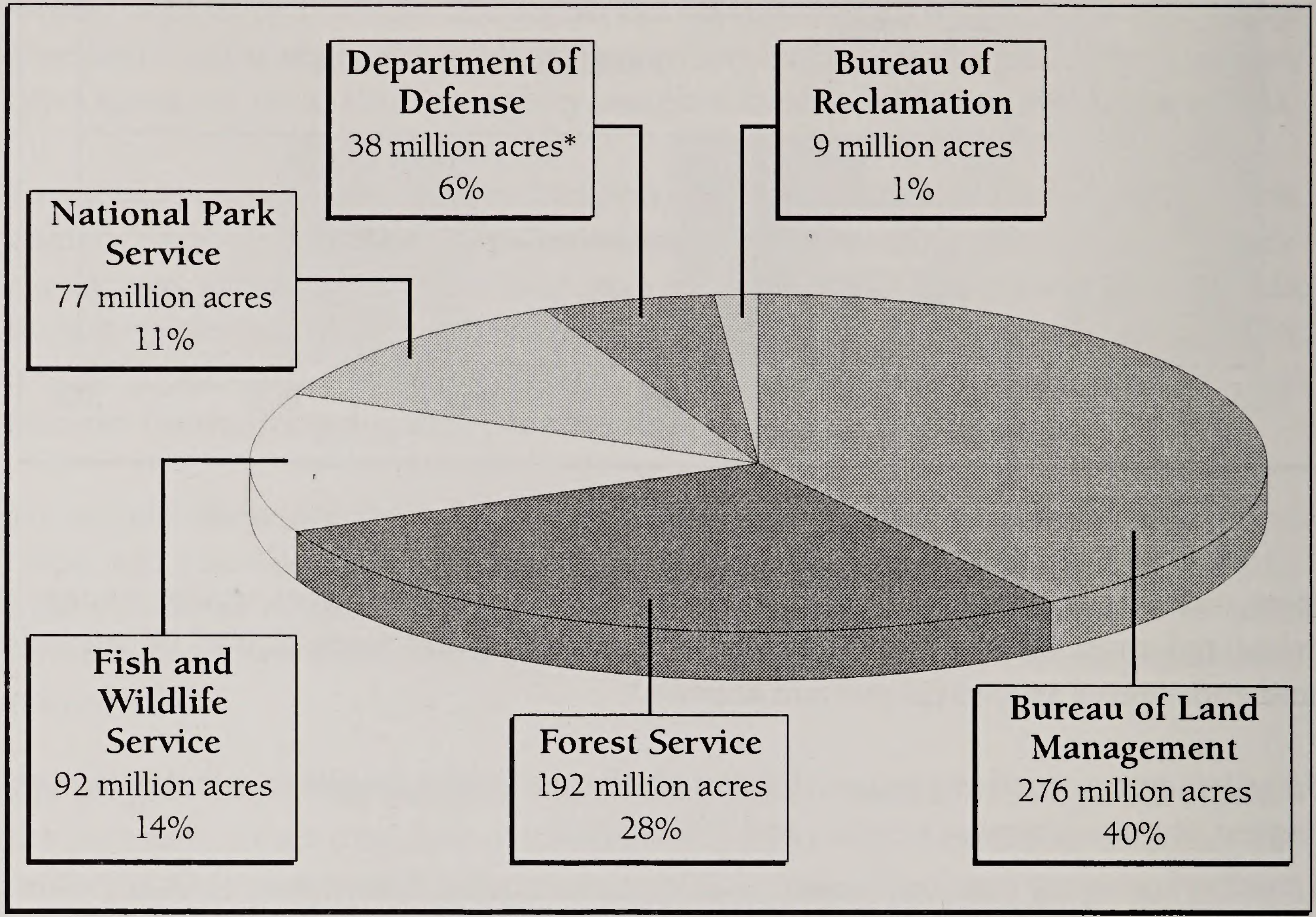
In order to carry out these responsibilities, the Forest Service maintains substantial surveying, mapping, remote sensing, and GIS operations.

- The surveying program maintains boundaries and survey markers to clarify ownership records and resolve legal disputes.
- The mapping program – largely centralized at the Geometronics Service Center in Salt Lake City – support planning, leasing, public access, and recreational purposes; it also produces the USGS Quads for national forest lands in a cooperative program with USGS.
- The remote-sensing program provides information for making large-scale ecological assessments of the forest lands, supporting the mapping program, fighting forest fires, and preparing fire damage restoration plans.
- The GIS program helps to organize the multiple sets of data needed to prepare ecologically sound forest management plans. GIS capabilities are in the process of being installed throughout the Forest Service to help empower the decentralized field structure to do its job better. The GIS Center of Excellence in Ogden, UT, is supporting this deployment.

Other Major Federal Land-Management Agencies

The four other federal agencies that manage large quantities of land are FWS, established within DOI in 1903: the NPS, established within DOI in 1916, the Department of Defense (DoD), which has roots all the way back to the beginning of the nation; and the Bureau of Reclamation (BOR) established within DOI under a different name in 1902. As land-management agencies, three of these organizations, and the civil works lands held by the Army Corps of Engineers (ACE) under DoD, have similar requirements for simultaneously providing public access while preserving the natural environment. The military lands held by DoD, of course, have more restricted uses. Thus,

FIGURE E-4: RELATIVE SHARES OF PUBLIC LANDS: SIX LARGEST FEDERAL LAND MANAGEMENT AGENCIES



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* Twenty-six million acres of military lands added to DoD Corps of Engineers' civil works holdings of 12.4 million acres.

Source: U. S. General Accounting Office, *Land Management Agencies: Major Activities at Selected Units Are Not Common Across Agencies* (Washington, DC: GAO, June 1977).

these federal agencies holding public-use lands all must maintain boundaries, provide public-use maps, and develop adequate GI to support sound, ecologically based, multiple-use management plans.

Among them, the six major land-owning federal agencies administer approximately 675 million acres, totaling approximately 30 percent of the entire U.S. territory. The relative shares of this land administered by these six agencies (shown in Figure E-4) are:

- BLM, 270 million acres (in 139 resource areas)
- the Forest Service, 191 million acres (in 155 national forests and 132 other units)
- FWS, 89 million acres (in 503 national wildlife refuges and 86 other units)
- NPS, 76 million acres (in more than 360 units)
- DoD, 38 million acres (including over 12 million acres of civil-works lands in about 460 projects)
- BOR, 9 million acres (in about 600 projects)

National Ocean Service (NOS)[4]

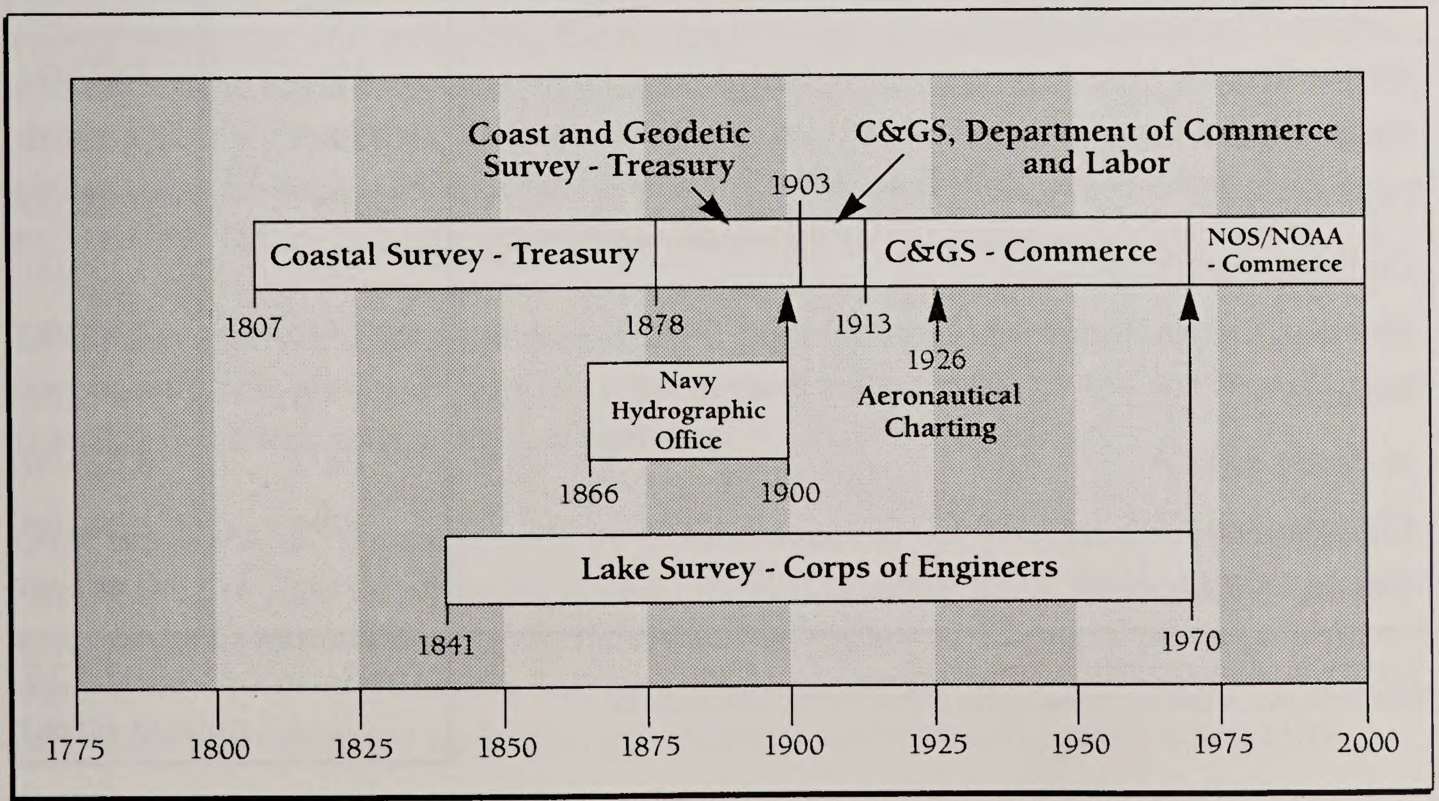
The antecedents to NOS go back almost to the founding of the nation. In 1807, Congress authorized President Jefferson "... to cause a survey to be taken of the coasts of the United States, in which shall be designated the islands and shoals and places of anchorage . . ." The Coast Survey was established in the Department of the Treasury shortly thereafter, but the new agency's first nautical chart was not published until 1835. It pursued related topics of tides, currents, magnetism, and geodetic surveying. Geodetic surveying was added officially to the organization's responsibilities in 1878 and its name was changed to the Coast and Geodetic Survey (C&GS) at that time.

Meanwhile, Congress created the Navy Hydrographic Office in 1866, which began a flourishing business as a maritime publisher, causing conflict with C&GS and calls for consolidation of the two organizations within the Navy Department. These proposals were finally defeated decisively in 1900, and Navy withdrew the military personnel it had been detailing to C&GS to assist with its research and to man the ships needed to carry out the nautical surveys. C&GS became part of the Department of Commerce and Labor when it was created in 1903, and it remained with the Commerce Department when it was separated from Labor in 1913. C&GS gained its own commissioned Corps in 1917, and that contingent remains part of the program to the present time.

Several reorganizations occurred in Commerce in the 1960s and 1970s that put C&GS in different parts of the Department, which was split it in two for a while, reunited again, and split once more. Presently, the Coast Survey and the National Geodetic Survey (NGS) are separate parts of the NOS, along with the Aeronautical Charting and Cartography Office. NOS, in turn, is part of Commerce's National Oceanic and Atmospheric Administration (NOAA) which contains several additional units, including the National Environmental Satellite Data and Information Service and the National Weather Service. Figure E-5 summarizes the evolution of NOS.

Currently, NOS supplies the nation's nautical and aeronautical charts. However, it is not able to keep nautical charts as up to date as desirable, and the Clinton Administration is planning to transfer the aeronautical charting function to the Federal

FIGURE E-5: HISTORY OF THE NATIONAL OCEAN SERVICE



Aviation Administration (FAA). NOS also maintains and improves the nation's geodetic control system.

NOS, using very limited resources, is applying new technologies to both programs to help keep up with growing demands for services. For example, such technologies as side-looking sonars and electronic maps will improve the completeness and quality of nautical charts, as well as their timeliness. In addition, satellite-based global positioning systems (GPS), with accuracies approaching one centimeter, are expected to make surveying much easier and less costly in the foreseeable future, and to allow accurate location of moving objects as well as stationary ones. NOS relies on others for the photogrammetry needed for aeronautical charting.

In a sense, NOS also has become a "land-management" agency. The Marine Protection, Research and Sanctuaries Act of 1972 established a new National Marine Sanctuaries program in which areas of special significance in coastal and ocean waters are designated for special attention. Since then, 12 sanctuaries have been designated to promote comprehensive management of their special conservation, recreation, ecological, historical, research, educational, and aesthetic resources.

These 12 sanctuaries are identified in Table E-1 by name, year of designation, and size. These areas might be thought of as the nation's underwater national parks. Together, they total just over 11.5 million acres, a number that lies between the 12.4 million acres managed by ACE and the 9 million acres managed by BOR.

TABLE E-1: NATIONAL MARINE SANCTUARIES, NOVEMBER 1997

Name	Year Established	Square Miles
Channel Islands, CA	1980	1,658.00
Cordell Bank, CA	1989	525.00
Fagatele Bay, American Samoa	1986	.25
Florida Keys, FL	1966	3,674.00
Flower Garden Banks, TX/LA	1992	56.00
Gray's Reef, GA	1981	23.00
Gulf of the Farallones, CA	1981	1,255.00
Hawaiian Islands Humpback Whale, HI	1992	1,300.00
Monitor, NC	1975	1.00
Monterey Bay, CA	1992	5,328.00
Olympic Coast, WA	1994	3,310.00
Stellwagen Bank, MA	1992	842.00
	Total	**17,973.25** (11.5 million acres)

Source: NOAA, *A Tour of the Sanctuaries* (Silver Spring, MD, undated).

Off-shore government jurisdictions are also an important consideration. The coastal states have jurisdiction out to about the three-mile boundary, and the federal government's jurisdiction extends from there out to the 200-mile boundary. Increased off-shore oil leasing and environmental protection activity make GI in these areas of growing importance.

U.S. Geological Survey (USGS)[5]

USGS was established by law in 1879 within the DOI. Its original missions were to provide information about the land, water, and mineral resources of the nation, including the geological structure underlying the surface. USGS's original interest in topographic mapping was related to its assessment of mineral holdings, but this feature of the land has also become highly useful for transportation and watershed planning.

When the irrigation needs of the arid western states became a federal mission in 1902, the Hydrographic Branch of USGS was a leading proponent. The Reclamation Service, which was originally established in USGS, became an independent bureau within DOI seven years later, and took on its present name – the Bureau of Reclamation (BOR) in 1923.[6] The history of water rights, the building of dams, and the provision of irrigation water has been a primary factor in the development of the West.

In pursuing these missions, USGS has become a leading supplier of base maps to other government agencies and to the general public. Its maps are the primary source of the basic features located on the nation's lands and their topographic elevations. USGS's most widely used maps, generally referred to as "quads" because of their systematic coverage of the entire nation with a uniform series of rectilinear sheets, are available for the entire U.S. and kept periodically updated.

USGS also is a repository of long-term national geographic databases, as well as a current supplier of maps to other mapmakers, planners, wilderness hikers, and a diverse array of other users. Much of the Survey's historic land-use and land-cover data have become indispensable to studies of long-term trends in urbanization and ecological conditions.

In recent times, USGS has been assigned additional responsibilities, including assessing energy resources, and evaluating the Forest Service's off-shore and on-shore resources, and evaluating hazards associated with earthquakes, volcanoes, floods, droughts, landslides, and toxic materials. The agency also develops methods for predicting and mitigating these hazards. On October 1, 1996, the National Biological Survey (NBS) was merged into USGS, bringing yet another dimension to its responsibilities.

USGS has nearly 10,000 employees in 400 field offices and four major mapping centers. In addition, it helps to support a network of state geologists and works with more than 1,000 federal, state, and local agencies.

Over the years, the methods used by USGS have evolved from laborious ground surveys to the use of aerial photography and satellite imagery. Its GI products now include not just paper maps, but computerized databases, nationwide aerial photography, and other remotely-sensed imagery. Increasingly, these products are produced through collaborative arrangements with other government agencies and private companies.

USGS is primarily an information-producing agency supporting other agencies and information consumers, rather than a user of its own information. However, USGS does prepare numerous analytical and interpretive studies, based on its own information and expertise. It is also a leader in helping to integrate GI sets and the development of GI systems (GIS). In this regard, USGS provides the secretariat for the Federal Geographic Data Committee (FGDC), which has responsibility for integrating geographic data within the federal government and for working with state and local governments toward that end. More will be said about FGDC later.

USGS faces several challenges, including proposals to terminate the agency, substantial downsizings, and legislated mandates to contract out increasing portions of its work in accordance with a set schedule. At the same time, its information resources are being used for many essential and high-profile public purposes, including:

- minimizing loss of life and property from natural disasters
- conserving and managing water, biological, energy, and mineral resources
- enhancing and protecting the quality of life
- contributing to sustainable economic and physical development

USGS's challenge is to demonstrate convincingly the relevance and essential nature of its information to meeting these legislated goals and to show that its established scientific objectivity and credibility are being maintained and upgraded in accordance with world-class standards. Collaborations with all sectors of the geospatial data community – both public and private – are being used to meet these challenges.

HISTORY OF THE FEDERAL LANDS

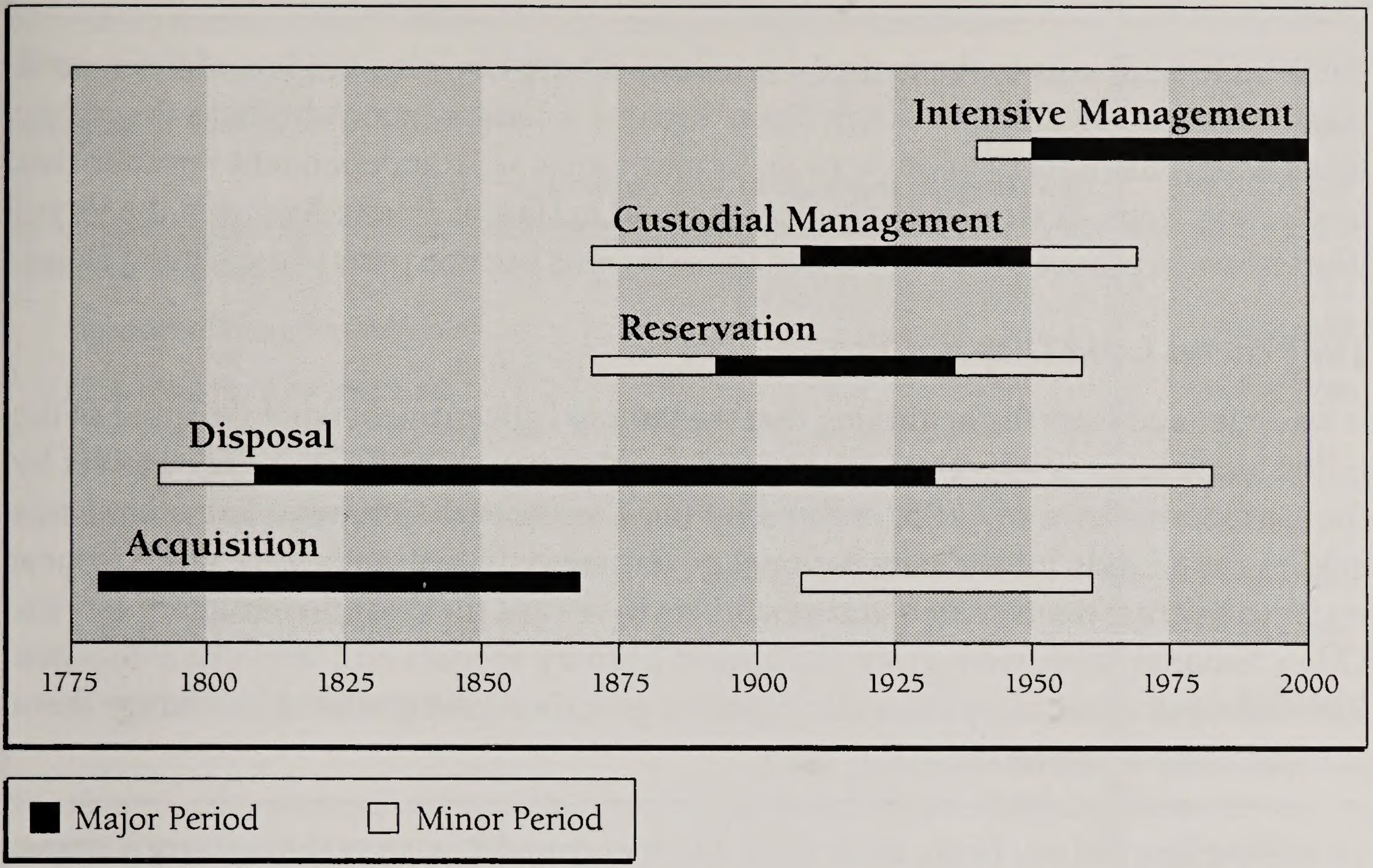
In the colonial period of America and for the first 100 years after independence, land was essential to individual wealth, financial security, social stature, and even the right to vote.[7] As important as land still is as one of the three fundamental factors of economic production (labor and capital being the other two), it is difficult for modern Americans to understand how much more important land was in the lives of almost all individuals when the nation was being formed than it is today. The availability of land was the magnet that attracted most of the immigrants to America. And the acquisition and disposal of land was of central importance to much of the federal government's nation-building policy for well over 100 years.

Because of the central importance of land policy to the nation's development, it is worth reviewing here. The history of the federal lands sets the stage for understanding the fundamental value of GI to the federal government.

The following brief summary traces five major overlapping eras of federal land ownership and land management:

- acquisition, from the beginning of the nation under the Articles of Confederation and as early as 1781, when some of the original colonies with very large territories ceded lands to the nation for later creation of new states, until the purchase of Alaska in 1867

FIGURE E-6: MAJOR ERAS OF FEDERAL LAND OWNERSHIP AND LAND MANAGEMENT



Source: Marion Clawson, *The Bureau of Land Management* (New York: Praeger Publishers, 1971), p. 4.

- disposal of over half of the public domain territories to encourage settlement between 1810 and 1934
- permanent reservation of public lands for conservation and the enjoyment of future generations, from about 1891 until the late 1930s
- custodial management, increased from about 1905 until 1950
- intensive management, increasingly from about 1950 until the present.

These eras are depicted graphically in Figure E-6.[8]

The Era of Acquisition

As previously mentioned, some of the original colonies had extremely large territorial land grants. The smaller colonies at the time the nation was formed were concerned that the newly formed states with larger territories would grow to dominate the new nation. Thus, a bargain was struck to cede large undeveloped territories to the nation so that new states of more equal size could be formed as the nation developed. In addition, the nation bought large territories, such as the Louisiana Purchase from France, Florida from Spain, areas that are now in New Mexico, Colorado, Kansas, Wyoming, and Oklahoma from Texas, and Alaska from Russia. The United States also gained public lands by treaties made with Mexico (California, Nevada, Utah, Arizona, and parts of New Mexico and Colorado) and with Great Britain (Oregon, Washington, Idaho, and parts of Montana and Wyoming).

Thus, in less than 100 years, the United States greatly expanded its territory and its title to public lands. In all, more than three-fourths of the present territory of the nation was, at one time, part of the original public domain.

Some other additions to the nation's territorial extent, however, did not add to federal land holdings. For example, when Texas became a state it retained title to the public lands within its borders because of its former status as an independent republic that broke away from Mexico. Virtually all of the land in Hawaii, Puerto Rico, and the Virgin Islands was in private ownership when those regions became parts of the United States.

The Federal Land Disposal Era

It was intended from the beginning that the national government would dispose of the public domain to promote settlement and development. This basic policy was set by the Land Ordinance of 1785, enacted by the Continental Congress. Some land was sold to raise funds for the new national government. Other lands were given to new states to help get them started and to soldiers to reward them for their military service. Other national lands were given to support primary schools and land grant colleges. Railroads and canal companies also received generous land grants to encourage them to open up new territories.

Homesteading did not begin until 1862, but it eventually became the country's largest land-disposal program. All told, nearly four times as much federal land was dispensed to private interests as was dispensed to the states. Table E-2 shows the amounts of federal lands dispensed by varying methods to different parties.

The Era of Permanent Reservation of Public Lands

Although Yellowstone National Park was established by a special act in 1872, there was no general policy of establishing permanent federal lands until an 1891 act of Congress authorized the President to establish permanent forest reserves.

A great expansion of national land reserves occurred in the early part of the 1900s. The national forests grew to approximately their present size by 1910, national wildlife refuges were initiated in 1903, and the few national parks previously authorized became part of a growing national park system in 1916. Although additional federal lands are still being set aside for permanent preservation, the period of rapid expansion ended in the mid-1930s.

The Era of Custodial Management

Until 1905, the federal government did very little to manage the public lands under its ownership. However, when the forest reserves were transferred from the DOI's General Land Office to USDA's Forest Service and renamed "national forests," a series of management practices was put into place: control of forest fires, defense against trespass, modest timber sales, controlled livestock-grazing, among others. Gradually, other authority was added, allowing federal managers to classify lands for appropriate uses and limit exploitation. However, the pressure to use these lands was not great until World War II.

TABLE E-2: DISPOSITION OF THE PUBLIC LANDS, 1781–1995

Type of Disposition	Acres
Disposition by methods not elsewhere classified[a]	303,500,000
Granted or sold to homesteaders[b]	287,500,000
Total unclassified and homestead dispositions	**591,000,000**
Granted to states for:	
Support of common schools	77,630,000
Reclamation of swampland	64,920,000
Construction of railroads	37,130,000
Support of miscellaneous institutions[c]	21,700,000
Purposes not elsewhere classified[d]	117,600,000
Canals and rivers	6,100,000
Construction of wagon roads	3,400,000
Total granted to states	**328,480,000**
Granted to railroad corporations	94,000,000
Granted to veterans as military bounties	61,000,000
Confirmed as private land claims[e]	34,000,000
Sold under timber and stone law[f]	13,900,000
Granted or sold under timber culture law[g]	10,900,000
Sold under desert land law[h]	10,700,000
Total miscellaneous dispositions	**224,900,000**
Grand Total	**1,144,380,000**

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[a] Chiefly public, private, and preemption sales, but includes mineral entries, scrip locations, and sales of townsites and townlots.

[b] The homestead laws generally provided for the granting of lands to homesteaders who settled on and improved vacant agricultural public lands. Payment for the lands was sometimes permitted, or required, under certain conditions.

[c] Universities, hospitals, asylums, etc.

[d] For construction of various public improvements (individual items not specified in the granting acts), reclamation of desert lands, construction of water reservoirs, etc.

[e] The Government has confirmed title to lands claimed under valid grants made by foreign governments prior to the acquisition of the public domain by the United States.

[f] The timber and stone laws provided for the sale of lands valuable for timber or stone and unfit for cultivation.

[g] The timber culture laws provided for the granting of public lands to settlers on condition that they planted and cultivated trees on the lands granted. Payments for the lands were permitted under certain conditions.

[h] The desert land laws provided for the sale of arid agricultural public lands to settlers who irrigated them and brought them under cultivation.

Note: Data are estimated from available records.

Source: DOI, BLM, *Public Land Statistics 1994/1995* (Washington, DC, 1996), p. 5.

The Era of Increasingly Intensive Management

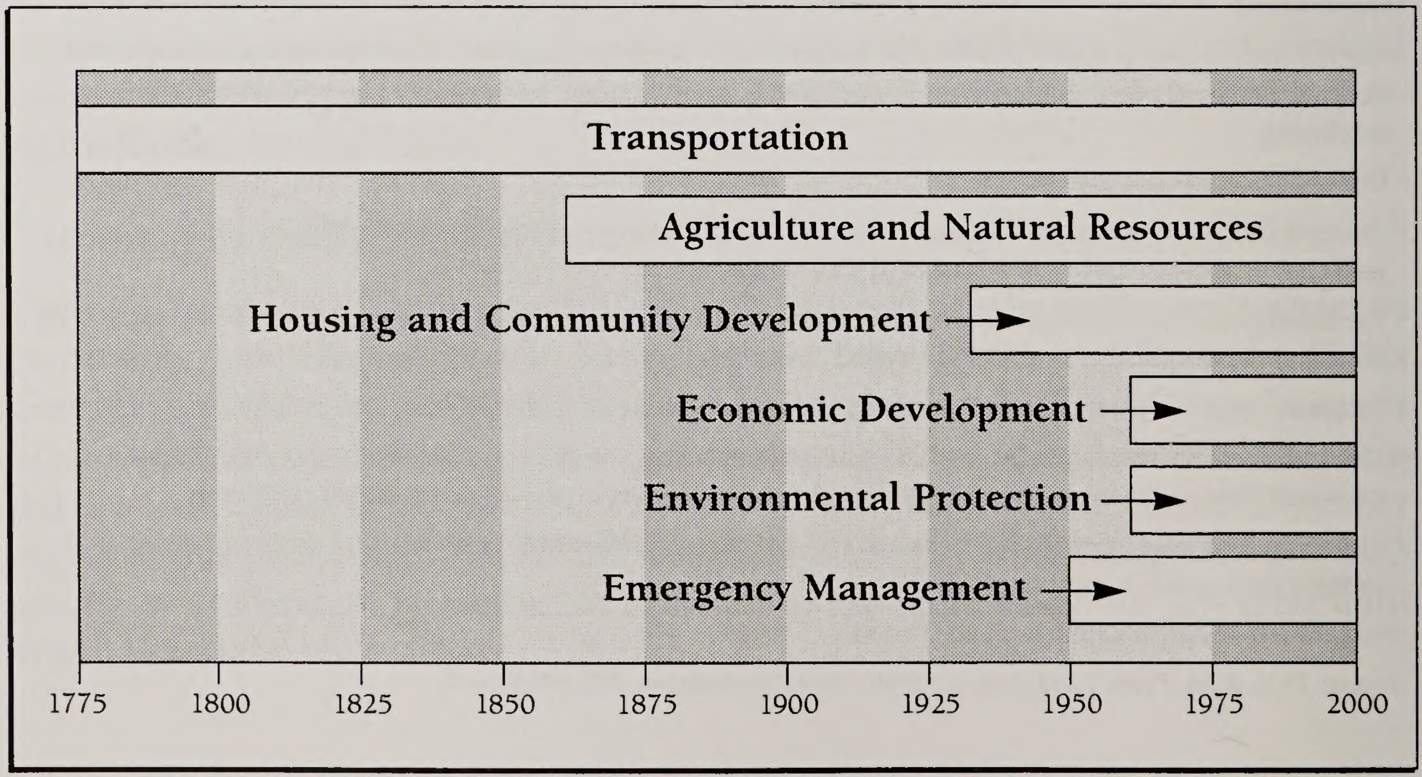
Timber and grazing uses of federal lands rose sharply during the War, but recreational uses fell. After the War, the timber and grazing uses remained high and recreational uses resumed rapid growth. By 1950, revenues generated from all federal lands exceeded the total cash expenditures on those lands for the first time in the modern era. Growing revenues and growing usage led to greater development and intensified management efforts. Productivity rose, but so did environmental sensitivities. Multiple-use concepts were devised to accommodate the multiple users who wanted to use the same lands for different purposes.

Today, science-based watershed planning and ecosystems management techniques increasingly are being practiced. These new management techniques require considerably more, and significantly different, types of GI than did earlier management programs. Environmental impact analysis, benefit-cost analysis, and intensive public-involvement processes now are common requirements in the management of the federal lands.

HISTORY OF OTHER PLACE-BASED FEDERAL PROGRAMS

The federal lands are by no means the only federal programs that are concerned with physical places and their well-being. Six other mainstream federal program areas are summarized below because they illustrate significant commitments by the federal government to use place-based policies that require and help to fund GI. These six program areas are: transportation, agriculture and natural resources, housing and community development, economic development, environmental protection, and emergency management. Figure E-7 shows the relative time frames over which these program areas have developed.

FIGURE E-7: LONGEVITY OF SELECTED FEDERAL GOVERNMENT PROGRAMS RELYING ON GEODATA



These programs tend to operate mostly through intergovernmental financial assistance and regulatory mechanisms. Thus, they also illustrate how intergovernmental mapping, geodata, and GIS collaborations work.

Transportation

Transportation has been a national concern at least since the Constitution was ratified in 1788. The Constitution clearly establishes the federal government's responsibility for post roads and for the transportation programs of the federal government that have developed and expanded steadily ever since. Examples are:

- Congress gave responsibility for river and harbor navigation to ACE in 1800. It also lent support to canal builders as early as 1817 and to the railroads as early as 1830. In 1916, Congress enacted a cooperative program with the states to build and improve farm roads and primary highways. The first federal support for civilian airports began in 1946.
- Construction of the National Defense Interstate Highway System began in 1956. With 90 percent federal funding, this state-run program ranks as one of the world's all-time largest public works programs. It also has created and funded the largest and most fully developed metropolitan planning program in the nation's history.
- Federal funding of local transit programs began with a very small program in 1961, but it grew rapidly through the 1960s and 1970s. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) brought the highway and transit programs much closer together, further enhanced metropolitan and statewide transportation planning processes, and provided flexibility in funding among different modes of transportation.

Today, ISTEA is one of the largest funders of state and metropolitan GIS systems that integrate wide ranges of transportation, land use, environmental, demographic, financial, and other types of geographic data. These systems produce maps and other graphic displays that help both officials and citizens to visualize the implications of alternative transportation investments.

In 1991, ISTEA established the Bureau of Transportation Statistics (BTS) within DOT. BTS has created its own GIS office because "transportation is essentially geographic." BTS is working closely with FGDC, Census, FHWA (which began building its own GIS in 1985), the state departments of transportation, and others to create and maintain a national transportation atlas and other GIS products. Among these products are several automated geographic data packages geared to the needs of state and metropolitan planners, including a package of census data that is of special use to them.

Agriculture and Natural Resources

In the 15 years between 1862 and 1877, the federal government used its public lands policies to encourage homesteading of farms and ranches, mining claims, growth of the timber industry, and the reclamation of desert lands. Just two years later, the first federal flood-control program was enacted. In 1899, soil surveys were authorized. USDA also has been a pioneer in producing snow surveys for estimating water supplies in the West, where most water comes from mountain snowpacks. This extraordinary outpouring of natural resources initiatives, beginning the year USDA was created,[9] launched a continuing set of federal activities that included irrigating much of the arid western United States (1902), producing hydropower (1928), undertaking river basin management (1933), stabilizing agricultural markets through acreage allotments for major crops (1933), funding small watershed protection (1954), and beginning the development of ecosystem management tools (1970).

USDA's long years of experience with soil surveys[10] and the photogrammetry needed to facilitate crop acreage allotments have made it a leader in large-scale GI for use by individual farmers and county-level planning committees. Most of them use maps at the scale of 1" = 400'.

The Natural Resources Conservation Service (NRCS) has taken the lead within USDA to create a nationwide series of Digital Orthophoto Quads (DOQs) at the 1:12,000 scale, and to gradually improve it to 1:4800. This work is under way with cost sharing by USGS, the Forest Service, and NRCS. The larger-scale and higher-quality mapping is necessary for working with local people and agencies.

Housing and Community Development

The federal government's involvement in housing began with depression-era mortgage insurance programs to help restart the home building industry and help raise the level of home ownership (1934). That program was followed three years later by the beginning of federally supported public housing (1937). Subsidized housing programs have gone through many redesigns since; today, most housing assistance is available in the form of rent subsidies for use in the private-housing market.

Urban renewal and comprehensive planning programs started in 1954. These programs required and paid for extensive mapping of complex urban characteristics, land-use policies, and infrastructure programs by cities, counties, metropolitan-planning organizations, and state planning offices. Some of the earliest urban geographic data systems were developed with funds from these programs.

The comprehensive planning funds for cities and counties were merged into the Community Development Block Grant (CDBG) program in 1974, and are still available. However, the comparable funds for state planning offices have not been available since 1980, and the Department of Housing and Urban Development's (HUD) metropolitan planning funds were eliminated in 1983.

Currently, HUD's Community Connections program electronically supplies statistical and mapped information to most of its 1,100 assisted jurisdictions to enable them to easily analyze the relationship of proposed uses of federal funds to anti-poverty strategies that help to ensure social justice.

Economic Development

Several federal economic development programs began in 1965. One created the Appalachian Regional Commission, which is a federal-multistate organization that sponsors planning and economic development projects throughout the Appalachian mountain range, from New York state to Alabama. Most of the planning and project development in Appalachia is performed by Local Development Districts (LDDs) which include both public officials and business leaders on their boards of directors.

Similar commissions were authorized to be established by agreement between the President and the governors of the states that wished to band together. Several were created under the 1965 act, but President Reagan withdrew his support in 1981 and they collapsed.

The 1965 legislation also established the Economic Development Administration (EDA) in the Department of Commerce and gave it programs for supporting regional Economic Development Districts (EDDs) similar to Appalachia's LDDs. EDA provides planning funds to the EDDs and supports public works and other economic development projects identified in the EDD plans. Most of the EDDs are in rural or small metropolitan areas having various degrees of economic distress.

Environmental Protection[11]

The initial federal environmental protection laws were for water pollution control (1965) and air pollution control (1967). The breakthrough year, however, was 1970 when the National Environmental Policy Act (NEPA) was signed and the Council on Environmental Quality and the Environmental Protection Agency (EPA) were formed. Since then, the air and water pollution acts have been strengthened considerably and additional acts have been passed to control solid and hazardous wastes, to clean up toxic dumps, to ensure safe drinking water, to control pesticides and other toxics, and to protect estuaries, wetlands, and the nation's coastal areas. Most recently, President Clinton issued an executive order calling for analyses and policies to ensure environmental justice for underprivileged neighborhoods. Environmental justice planning calls for a new type of geographic analysis seldom performed before.

All of these programs are inherently geographic, highly data-intensive, and quite burdensome. EPA regulates and maintains data on 790,000 facilities that have the potential to emit pollutants. The success of EPA's regulatory programs rests on achieving a better understanding of the often complex spatial relationships between natural resources and human populations as they relate to potential or known pollution sources.

To help all of the regulated parties comply more easily and more effectively, EPA is developing an online national GIS system designed to cut permit-processing times, relieve data reporting burdens, and link all of the affected parties, including the general public. The system will allow anyone to download maps and statistics to meet their own needs whenever they need them. The system merges an extensive library of environmental and ecological facts with wide-ranging demographic and transportation data bases.

Emergency Management

The federal government's involvement in emergency management was established initially in the Constitution, which states that "Congress shall have Power to . . . provide for calling forth the Militia to execute the Laws of the Union, Suppress Insurrections, and repel invasions." (Article I, Section 8.) This provision was added largely because of the inept response of the national government to Shay's Rebellion in 1786, acting under the much weaker Articles of Confederation. This constitutional provision to control civil disorders was first used in 1792, and it has been used numerous times since then.

Federal responses to emergencies other than civil disorders also began very early in the nation's history. For example, federal resources were made available to Portsmouth, NH, in 1803 to help it recover from a disastrous fire. By 1905, the federal government was involved in responding to so many types of disasters that the Congress chartered the American Red Cross as the agent for coordinating federal aid with nonfederal assistance to disaster victims. The formal federal role in civil defense began in 1916 with Congressional enactment of legislation responding to the needs of World War I.

Despite this long history of federal involvement, civil disorders, disasters, and civil defense were considered primary responsibilities of state and local governments and the private sector. Individual federal agencies responded to individual events at the direction of the President. There was no lead federal agency to coordinate these efforts until 1951.

Table E-3 shows the evolution of U.S. emergency management agencies from an office in the Housing and Home Finance Agency into the present Federal Emergency Management Agency (FEMA). State, local, and private agencies still retain important roles and responsibilities for emergency management, as do many individual federal

TABLE E-3: ORGANIZATIONS AND FUNCTIONS TRANSFERRED TO FEMA

Agency	Location Before Joining FEMA	Function
Defense Civil Preparedness Agency	Department of Defense	Administered national civil defense
Federal Disaster Assistance Administration	Department of Housing and Urban Development	Coordinated and funded federal response to natural disasters
Federal Preparedness Agency	General Services Agency	Coordinated civil planning for national emergencies
Federal Insurance Administration	Department of Housing and Urban Development	Managed flood insurance and hazard reduction programs
National Fire Prevention and Control Administration	Department of Commerce	Administered the federal fire prevention program
National Weather Service	Department of Commerce	Preparedness for natural disasters
Office of Science and Technology	Executive Office of the President	Earthquake Hazard Reduction, Dam Safety coordination, and Federal Emergency Broadcast System

Source: National Academy of Public Administration, *Coping With Catastrophe* (Washington, DC, February 1993), p. 15.

agencies, but now there is greater federal leadership and coordination, including more attention to the mitigation of risks to help reduce losses (prevention), and to preparations to respond to events more quickly and effectively.

FEMA relies heavily on GIS for both planning and loss estimation, as well as immediate response to emergencies. Currently, its GIS systems are piecemeal, but work is under way to integrate the parts within the next two years.

The new system – the National Emergency Management Information System (NEMIS) – will connect all states and the 27 federal agencies that are currently included in the Federal Emergency Response Plan. Until all of the states are linked to the system, FEMA has portable systems that can be taken to the site of an emergency (with technical support) to be set up quickly and put the site on line with the latest response information.

The system contains such information as the locations of flood plains, pipelines, electrical power transmission grids, and chemical and biological airborne releases. FEMA collects many of these data on large-scale maps and digitizes them itself (with contractor assistance when necessary).

EVOLUTION OF GIS BUILDING BLOCKS

Over the years since the nation was created, massive amounts of GI have been collected for many different purposes. These purposes have been essential to the building of the nation, and they will continue to be just as essential in the future. In fact, the prospect is that they will become even more important in empowering public policymakers, as well as a growing number of program managers and administrators to become more effective and efficient in carrying out their responsibilities during times of fiscal stress.

The means for realizing the potential power of GI to improve government is the geographic information system (GIS), which has the power to integrate GI from many different sources into an analytical database that can interrelate, compare, and contrast diverse characteristics of places in the past, present, and future, and estimate the differential effects of alternative public policy proposals . . . **IF**. The "if" refers to the necessity of having the relevant data in the system in compatible forms. Availability of integrated data has been a very big problem in the past, but it is diminishing as more GIS users work to improve their systems.

As the foregoing sections of this paper have indicated, GI systems are being developed in many federal agencies, and some are beginning to integrate data from a wide variety of sources.[12] State and local governments and agencies are developing even larger numbers of GISs and investing more in them than the federal government.

Unfortunately, the data-integration process for creating GI systems frequently has been a long, tedious, and costly one, requiring a great deal of hand work – work that should be unnecessary to repeat, but which now is being done over and over.

The building blocks that make GI systems possible have been developed and are available. The challenge now is to put them together to create efficient systems that can be maintained without unnecessary duplication of effort by the thousands of local governments already using such systems and by the many others are likely to become GIS users in the years ahead.

The following list briefly summarizes the basic GIS building blocks and their origins:

- **Land Surveys** – PLSS, with origins in 1785, covers the original surveys for over three-quarters of the present land area of the United States, even though only about 28 percent of this territory still remains in federal ownership. This is because much of the land now owned privately or by the state and local governments was in the nation's public domain at one time.

  These PLSS records, maintained by BLM, are supplemented by state-established land records systems, most of which are administered by the nation's 3,000 counties. In Connecticut, Rhode Island, and Vermont, land records are the responsibility of municipal and town governments.

  These land records establish land-ownership parcels that are subject to regulation, taxation, and transfer. Thus, there is great incentive to ensure that these records are both accurate and complete. However, many of them have not been automated, so they are difficult to work with.

  Land parcels are the base for many local GI systems, though they are seldom used in state and national GIS. In local GIS, many other types of GI are integrated by referencing them to land parcels.

- **Street and Address Files** – The U.S. Census Bureau has relied on mailed questionnaires increasingly in recent decades. As a result, it has a need, once every ten years, for a complete and accurate address list for every household in the nation. These address lists were automated and tied to digitized street maps for the 1980 and 1990 censuses. The 1990 Census "TIGER" files (containing all streets and the address ranges associated with them) were made readily available on a CD-ROM, and have become the basis for many commercial and local government GI systems.

- **Geodetic Control and GPS** – The accuracy of land surveys and maps depend on known points on the earth's surface that are precisely measured and marked. The geodetic survey maintained by NOS provides the basic set of known points, and those points are supplemented with additional points established by other government agencies (densified) as the basis for property surveys and mapmaking.

  The GPS, developed by the military to meet its worldwide navigation needs, is now available to civilian users. This system is making it quicker and vastly cheaper to attach fairly accurate locations to many types of data collected in the field. With the proper equipment, many types of data can be both collected and located automatically in digitized formats ready to be entered into GI systems. Current accuracies are on the order of one meter, and future accuracies are projected to be on the order of one centimeter.

  Accurate location of data is the single most important key to integrating geographic data sets.

- **Base Maps** – The USGS Quads (at the scale of 1:24,000) are among the most widely used maps. With their uniform, nationwide coverage of topography and physical features, they are frequently used as the base for mapping by other federal agencies, state agencies, and many local planning agencies that do not need property lines, parcel identification and other details.

Many of these Quads are digitized and the rest eventually will be. Thus, they can be used increasingly as the basis for GI systems without having to be digitized by each new user.

- **Remotely-Sensed Data** – Aerial photography for the whole country, initiated by USDA in the 1930s to support cropland allocation programs, now has evolved into an interagency National Aerial Photography Program coordinated by USGS (and funded by USGS, BLM, USDA, and the TVA) to maximize the use of scarce federal funds for this purpose, and to increase the frequency of new coverage. Photographs are available in different scales ranging from 1 inch = 5,000 feet to 1 inch = 200 feet.

  NRCS has initiated a cooperative national program to produce Digital Orthophoto Quads (DOQs) at the scale of 1 inch = 400 feet. This scale which is larger than those now commonly being used in federal programs, would allow NRCS and other federal agencies to work more closely with local constituencies and with city and county governments, and to take advantage of local updates arising from transactions that take place on the land. Three advantages of this innovation would be to (1) break the cycle of long periods of increasingly out-of-date maps, punctuated by very short periods of fairly current information, (2) allow the nesting of large-scale and small-scale mapping to meet the needs of many users, and (3) provide consistent data that could span boundaries between local governments, states, watersheds, ecosystems, and other analytical areas.

  A cooperative program is now under way between USGS and three USDA agencies (NRCS, the Forest Service, and the Farm Services Agency) to begin producing this series at somewhat larger scales while expanding the partnership through state and county cost-sharing agreements that would enable the larger-scale products to be achieved in later years.

  In addition to aerial photos, satellite imagery with a variety of sensor types is becoming available to provide very rapid updates to GI on large areas. These are valuable for a variety of purposes, such as predicting forest fires by spotting stressed vegetation, fighting forest fires, preparing forest recovery plans after major fires, tracking floods and storms, evaluating the health of crops, tracking changes in urbanization, and tracking pollution sources and impacts. Many of these concepts have been developed and proven by the National Aeronautics and Space Administration (NASA), and then made operational by other agencies and/or private companies.

- **The Personal Computer Revolution** – The invention and diffusion of personal computers (PCs) has placed large computing capacities on many desktops in federal, state, and local agencies where GI is important. These developments created a great demand for specialized GIS hardware and software. Such hardware and software is now widespread, and its use is growing rapidly, even in many small local governments. Commercialization of these systems has made them affordable and relatively easy to use.

- **Thematic Data** – As indicated in the brief histories of place-based public functions presented above, geographic data of many different types are being digitized increasingly so they can be integrated into GI systems. In addition to the transportation, agriculture and natural resources, housing and community development, economic development, environmental protection, and emergency management functions already presented, similar trends are occurring in many other public service fields. Examples include welfare-to-work, crime fighting, the siting of fire stations and many other public facilities, and the optimum routing of trash trucks, buses, and delivery vehicles. Frequently, the application of the GI system to a new function of government takes little more than adding another layer of data to the data already in the system.

THE BEGINNING OF GEOGRAPHIC INFORMAITON (GI) COORDINATION

Early Efforts

Although the need for coordinating geographic data was recognized when OMB Circular A-16 was first issued in 1953, it has been slow to develop. The circular was revised in 1967 to give responsibilities to DOI for coordinating topographic information, to the Commerce Department for coordinating geodetic information, and to the State Department for coordinating information about international boundaries.

In 1972, the Army, Navy, and Air Force mapping agencies were consolidated into a single organization called the Defense Mapping Agency (DMA). The next year, an OMB task force made a similar recommendation to consolidate the civilian mapping agencies into a single agency, but that recommendation has never been implemented. However, consolidation continued in the defense establishment when the mapping and imaging agencies were combined in 1996 to form the National Imaging and Mapping Agency (NIMA).

In 1975, the Civil Applications Committee was established to give the federal government's civilian agencies a mechanism for working with the defense and intelligence communities to take advantage of new GI technologies developed in those fields that might be declassified for civilian use.

As digitizing of the USGS Quads began to occur in the 1980s, an interagency committee was established to monitor it. Formalized in 1983, this committee was renewed in 1986 and 1989. Then in 1990, Circular A-16 was revised to combine all of the former civilian mapping coordination activities and expand their scope under a new 12-member interagency committee called the Federal Geographic Data Committee (FGDC). Seven new types of data were added to the three that had been included earlier.

The charter of FGDC is open-ended so that it can grow to represent the expanding needs of the geographic data community. Two agencies have been added since 1990 – the Library of Congress and TVA. In addition, state and county representatives were added in January 1997.

NSDI

Executive Order 12906, issued in 1994, gave FGDC responsibility for promoting the NSDI concept. This concept, which has been supported by the Mapping Sciences

Committee of the National Academy of Sciences and USGS was brought into the mainstream of government through a recommendation of the National Performance Review (NPR). It provides a framework for linking all federal, state, local, and private geographic data together over the Internet. It relies on five key elements:

- a framework for spatial location
- content-classification standards for thematic data sets
- metadata which index and document the geographic data that are available from each source that is linked to the system
- a clearinghouse mechanism for sharing data among participants
- partnership arrangements for working together to produce quality data for the system

The seven types of data currently receiving the greatest attention are geodetic control, boundaries, land parcels, elevations (topography both above and below water), water resources, transportation, and digital imagery.

Some progress is being made in developing all of the elements of NSDI, but there still is a long way to go before the promise of the concept will be fulfilled.

Mission Integration

The agencies that appear to be making the most progress in developing integrated GI systems are those with the broadest missions. At the national level, two agencies illustrate this point – FEMA and EPA. Both have multi-million dollar efforts under way to develop GI systems to link them with their federal, state, and local program partners who are critical to their programs' success.

HUD's Community Connections program and DOT's packaging of census data of special interest to its clients are less ambitious, but significant examples of data-integration to improve mission success.

DOT's Condition and Performance Report to Congress on the nation's surface transportation systems illustrates the value of reverse flows of geographic data from the state departments of transportation, metropolitan planning organizations, and transit authorities to a federal agency for use at the national level.

The federal land-management agencies are taking steps to establish GI systems primarily for their own use. However, their progress toward that goal is slow.

State and Local GIS Coordination

Local governments may be furthest along in developing integrated GI systems because of their long-term experience with comprehensive planning for community development, a substantial amount of federal planning assistance, and the very large number of federal planning and environmental requirements that they must meet. Regional planning organizations in metropolitan areas also are leaders in GIS because of U.S. DOT requirements and funding for comprehensive transportation planning. Many of these efforts date back to the 1960s.

State GI activities are more like the federal agency-by-agency applications than they are like those of local governments. Only a handful of states have anything approaching multipurpose state-planning functions. Nevertheless, 41 states now have state GIS coordinating councils that might be considered counterparts to FGDC, and they formed a national association in 1991, the National States Geographic Information Council (NSGIC), which supplies the newly established state representation to FGDC. The local representation is supplied by the National Association of Counties (NACo).

ENDNOTES

[1] James Muhn and Hanson R. Stuart, *Opportunity and Challenge: The Story of BLM* (Washington DC: U.S. Government Printing Office, September 1988).

[2] U.S. General Accounting Office, *Land Management Systems: Progress and Risks in Developing BLM's Land and Mineral Record System,* (Washington, DC: August 1995).

[3] Glen O. Robinson, *The Forest Service: A Study in Public Land Management* (Baltimore, MD: The Johns Hopkins University Press, 1975).

[4] National Academy of Public Administration, *A Performance Based Organization for Nautical Charting and Geodesy,* (Washington, DC: National Academy of Public Administration, June 1996).

[5] Mary C. Rabbitt, *The United States Geological Survey: 1879–1989,* USGS Circular 1050, Reston VA: URL http:\\www.usgs.gov\reports\circular\c1050\c1959,gtnkm (Last modification: 08-14-96).

[6] William E. Warne, *The Bureau of Reclamation* (New York, NY: Praeger Publishers, 1973), p. 4.

[7] Marion Clawson, *The Bureau of Land Management* (New York, NY: Praeger Publishers, 1971).

[8] This figure and the narrative which follows it are drawn from Clawson, Chapter I.

[9] U.S. Department of Agriculture, *After A Hundred Years: The Yearbook of Agriculture* (Washington, DC: U.S. Government Printing Office, 1962).

[10] Fredrick R. Steines, *Soil Conservation in the United States* (Baltimore, MD: The Johns Hopkins University Press, 1990).

[11] Marc K. Landy, Marc J. Roberts, Stephen R. Thomas, *The Environmental Protection Agency* (New York, NY: Oxford University Press, 1990). The Council on Environmental Quality, *Environmental Quality: 1970–1990: Twentieth Annual Report* (Washington, DC: U.S. Government Printing Office, undated).

[12] U.S. General Accounting Office, *GI Systems: Information on Federal Use and Coordiantion,* (Washington, DC: September 1991).

APPENDIX F

International Trends and Comparisons

Changes and developments in the national organization of geographic information (GI) are not restricted to the United States. Other countries are modifying their policies, structures, practices, and intra- and inter-governmental relationships to accommodate the growing demand for maps and geo-referenced geographic, political, and cultural data. Their experiences and approaches often reflect their different forms of government, the history and traditions of their leading geographic institutions, and their differing cultural and social values.

This appendix summarizes recent developments in several countries and their approaches to organizing national GI and implementing institutional and policy changes to meet altered public and private expectations and capabilities. The recent experiences of four countries are assessed in some detail. These include:

- the United Kingdom, which has moved toward a central government corporation for GI
- Canada, which originally devolved many of its GI activities to its provinces, but is now in the process of re-centralizing standards
- Sweden, where GI functions are being extensively privatized
- Japan, where there is a strong unitary government approach to geospatial data.

Major changes in some other major countries are also briefly highlighted.

In most countries, there is significant involvement by multiple government levels in geospatial information. Governmental relationships with the private sector vary widely, however. These experiences and this appendix provide alternatives that are useful to keep in mind as changes in American approaches are explored elsewhere in this report. The identification of these experiences is, however, not intended to provide, nor does it provide, a blueprint for future changes to U.S. policies, organizations, and implementing actions affecting GI.

The United Kingdom[1]

The United Kingdom has a unitary, nonfederal form of government with a history of strong central direction of its surveying, mapping, and GI collection and dissemination. Its Ordnance Survey (OS) has a long tradition of providing high-quality surveys and maps both at home and abroad.

In recent decades, the UK government has moved aggressively towards more businesslike methods internally, as well as increased privatization and contracting out of traditionally government services. The UK government has created a large number of so-called "executive agencies," comparable to performance-based organizations in the U.S. Seventy-five percent of all civil servants formerly working in government departments have been transferred to more than 140 executive agencies since 1989.[2] These agencies submit corporate plans that establish annual targets set by cabinet ministers. Each agency is evaluated every five years as to whether its service is still needed and, if so, whether the service can be met by the private sector.

Structure and Organization

The OS was reorganized into a domestic mapping organization in the 1980's as one of the executive agencies described above. The OS is the primary civil mapping and GI agency in the UK with approximately 2,000 staff members. The primary GI functions of OS are:

- maintain, improve, and safeguard the national topographic database, including
- map creation and updating
- provide national coverage of maps and data for emergency purposes
- produce maps to meet parliamentary statutes and regulations
- collect and produce digital geographic data
- make database products and provide cartographic, printing, and related services.[3]

The role of OS is to ensure the existence of an adequate GI framework for the entire country, to ensure that this framework is sufficiently up to date for high-priority needs, to bear a portion of the cost of this framework in noncommercial areas, and to ensure equity of access. The OS, as a leader in the field of geospatial and topographic data, provides linkage among mapping, GI, and modern technology, and builds long-term relationships with customers, suppliers, and business partners.

Public Purposes

Executive agencies collect a wide variety of geographic, political, cultural, and statistical data, a service considered central to government's role in policymaking and resource allocation. The OS's focus is on geographic and land information. Major guidelines on governmental responsibilities in surveying, mapping, and GI that are defined in the government's *National Interest in Mapping* (June 1996) include:

- public interest in mapping areas that would not otherwise be mapped if decisions were made strictly in terms of generating revenue
- national consistency of content, currency, style and manner of mapping dictated by the needs other than those of the local market, including occasions when the information is used for defense purposes and when external economic benefits result

- creation or maintenance of the infrastructure of mapping that is used by other bodies and by the public and where charging is inappropriate or impossible.[4]

The government provides the policy guidance, such as the above, under which OS operates. The OS's commercial services are customer-driven; and who delivers services and how they are delivered are not of primary concern. Services considered to be "uncommercial" are geodesy and coordinate systems, rural mapping, advising the government on GI, and acting as a representative of the UK in the international sphere. OS also deals with policy issues; it offers expert advice to the government marketing, planning, and information technology related to GI.

Leadership and Coordination

The OS coordinates data collection and integration, primarily by assembling data from many different players and agencies, "sewing" the resulting data sets together, and making the data publicly available. It also has the role of acting as coordinator and guardian of adherence to mapping standards.

The National Interest in Mapping Service Agreement (NIMSA) of 1995 (to be addressed again in 1998) is meant to address the activities that are not completely uncommercial but are in the national interest. NIMSA is a de facto agreement between OS and a surrogate customer (the government and its departments). Funds made available under the NIMSA agreement are treated as revenues, not as a government subsidy.[5]

Other leading GI-related organizations in the UK include the Local Authorities Ordnance Survey Committee, which advises the OS on its interaction with local governments that are responsible under the Right-of-Way Act for street and utility data. The Association for Geographic Information (AGI) is a nongovernmental organization, though it receives a small amount of annual funding ($200,000) from the central government, which promotes the use of GI. The Inter-departmental Group on Geographic Information, chaired by the Department of Environment, provides a forum for government departments to share information about GI and to coordinate joint action where necessary.

Relationship with the Private Sector

The UK government generally and OS in particular have promoted an increasing role for the private sector in the UK. Services provided by the Civil Service are tested against the private sector, and if they do not measure up to competition from the private sector, are contracted out to the private sector.

Geographic data are sold by licensed agents through data brokering, and they are incorporated in many products produced by other organizations. In 1996, OS had more than 50 value-added resellers and about 200 licensed developers of software.[6] This arrangement has increased revenues. In addition, standard paper maps are available though commercial retail outlets, and print on demand mapping is franchised to private sector agents.

Pricing and Intellectual Property Rights

All OS products are covered by Crown Copyright and protected by strong legislation. Intellectual property rights and pricing issues are covered by various forms of legislation in the UK, including the 1994 Code of Practice for Access to Government Information, the Tradable Information Initiative of 1986, and European directives translated into British law (Directive 90/313/EEC) covering access to environmental information and protection of intellectual property rights.[7]

OS is moving rapidly to full-cost recovery. Revenues have increased 48 percent since 1991 and accounted for 93 percent of total cost in 1996/97.[8] It is estimated that 80 percent of its revenues are underpinned by intellectual copyrights. Currently, the central government pays for uncommercial mapping activities, but the approach in the future is uncertain. Possibilities being considered include a cost-share agreement between the central government and local users/creators (possibly a new form of taxation), end-user charges, or government subsidy.

Canada[9]

Unlike the UK, Canada has a federated governmental structure similar to that of the U.S. As in the UK, the roles of governments are changing; some former responsibilities are being distributed to other organizations. In Canada, however, the provinces, rather than a government enterprise or the private sector, assumed many GI activities early on, but the country is now in the process of re-centralizing some functions.[10]

Structure and Organization

In the late 1960s, the Canadian national government became more involved in land-use management. It helped develop GI software, but this software responded poorly to users' needs. Scale (1:50,000 or smaller) and image resolution were major drawbacks. Thus, the role of national government came into question and the role of the provinces gradually grew in importance. Nearly simultaneously, several Canadian provinces, including New Brunswick and Ontario, were in the process of centralizing their property-assessment functions and establishing provincewide mapping and appraisal capabilities. The provincial mapping and GI organizations were less constrained in experimenting and both closer to, as well as more attentive to, customers' demands. They pioneered larger-scale databases at 1:10,000 and 1:5,000 to replace the 1:50,000 scale databases that were of limited value to provincial and private customers. Since the provinces had limited in-house GI resources, these activities were largely and, in most cases, successfully contracted out.

In the 1990s, most provinces integrated their GI functions and activities into one or two organizations. New Brunswick, for example, created a provincial corporation. It reports to a government corporation board of directors and a minister regarding policy issues. It has a mandate for all land administration and core mapping in the province, and it coordinates GI by setting standards and auditing other government agencies' geo-referenced data activities. It has become 100 percent self-sufficient, largely through its ability to charge for value-added services in the area of land records.[11] Other provinces have also established similar organizations.

In 1993, however, Natural Resources Canada (NRC) was created as a result of a merger of the Department of Energy, Mines and Resources, and the Department of Forestry. NRC's mission is to promote sustainable development and responsible use of Canada's mineral, energy and forestry resources. It is to develop an understanding of Canada's land mass and manages a national GI technology development program.[12] Canada's national mapping agency, the National Topographic Center, resides in the NRC.

The Geodetic Survey Division (GSD) is also part of Canada's Earth Sciences Sector of Natural Resources Canada (NRC) and covers geodetic work. GSD, much like the United States' National Ocean Service's National Geodetic Survey (NGS), maintains, improves, and facilitates access to Canadian Spatial Reference System. It includes the national coordinate system for use with all mapping, charting, navigation, and other needs. A Canadian Active Control System (CACS) provides users of GPS with access to the national standard for positions. GSD also maintains the Canadian Base Network (CBN) to provide a high-accuracy network of grounds monumentation.[13] The Canadian Hydrographic Service, part of the Department of Fisheries and Oceans, covers nautical charting and related activities.

The central government works in conjunction with the provinces on data and project priorities. Joint ventures and cost-shared agreements between the federal government and provincial governments are used to develop and share manual and digital geographic data that fits into a national topographic database and to promote GIS technology.

Public Purposes

During the late 1960s, Canada's provinces have become increasingly important in GI, experimenting with technologies, producing larger-scale databases, and contracting work out to the private sector. By the late 1980s, provinces increasingly began to link their many independent GI databases into a provincewide data sets.

The national government does not regard managing GI databases beyond the National Topographic Data Base as one of its core responsibilities. Originally, the Canadian Council of Geomatics (CCOG), composed of the main provincial and federal mapping organizations developed standards. CCOG is chaired by a provincial representative and driven by provincial interests and nominally represents the public and its concerns. But, in late 1996, CCOG asked the federal Inter-Agency Committee on Geomatics (IACG) to take the lead to create a Canadian Geospatial Data Infrastructure. IACG has formulated a "soft leadership" approach with no single lead agency and nonmandatory standards and partnership development. It has adopted the U.S. metadata standard and, like the FGDC, is working to develop a framework of basic data sets.[14]

Leadership and Coordination

Leadership and coordination has been decentralized because of the rise of provincial dominance in GI. A nominal lead now rests with the Inter-agency Committee on Geomatics (IACG), composed of central government agencies and chaired by Canada's national mapping agency. Its aims are shared development and exchange of geomatics data, documentation and dissemination of information about geomatics activities by federal agencies, cooperation in data collection, development of databases, and dissemination of geographically referenced information, and consultation on research and educational programs.[15]

Role of the Private Sector

The governments develop data requirements, and private companies contract to meet these requirements. Companies are encouraged to initiate value-added enterprises to maximize GI/GIS use. Some functions formerly performed by national government employees have been contracted out to the private sector as a result of a contracting-out agreement in 1988 following a Treasury Board determination that further opportunities for contracting work to the private sector should be investigated and implemented. In addition, a private-sector trade association, the Geomatics Industry Association of Canada (GIAC) promotes Canadian GI/GIS domestically and abroad.

Pricing and Intellectual Property Rights

Government data is copyrighted in Canada and, nominally, all federal information is protected by copyright. This is not, however, enforced as strictly as in the UK, for both political and practical reasons.

Canada's Federal Access to Information Act of 1983 provides that federal and provincial governments pursue cost recovery through database dissemination. According to federal guidelines, charges for public information are expected to cover the full cost of the government making the resource, right, or privilege available. Government agencies are to provide information only when there is a clear duty to inform or when users are willing to pay for the information. If the value of the right or privilege to the user goes beyond the cost of making the information available, this value is taken into account. When appropriate, user fees and charges are applied for provision of information and related services. While the national government attempts to police copyright protection, it is more concerned about how data is used and ensuring against abuse.

The Canadian Treasury Board attempted to disseminate government information using this cost-recovery approach in the 1990s. Federal agencies were to generate revenue in the delivery of information resources to the public and private sectors. The federal government thought that people would pay for data that had the federal stamp of approval, but the marketplace for information exploded. The federal government had a monopoly for less than two years, but it had to drop prices because of increased competition from private providers.[16]

In Canada, public access to data is largely considered to be mandatory, and pricing policies are seen as potentially inhibiting access to information. People found alternative ways of getting public information. The government found that property information, for example, could not be denied to people, and the government found it impossible to ask its citizens to pay for information about their own neighborhoods. As a result, some information that most citizens need is made available without cost. GI agencies, thus, could not become truly self-sufficient just through selling information. Though many GI organizations are increasingly self-sufficient, it is not from selling information, but from providing value-added services.

Sweden[17]

Surveying and mapping in Sweden have their roots in the National Land Survey, established in 1600s. Later, in the 19th century, most mapping was done by the military. In 1937, a civil Geographical Survey Office took over official mapping. These two organizations, the National Land Survey (NLS) and Geographical Survey Office, were merged in 1974. Real property register and the land/title register were converted between 1971 and 1995 to a land data-bank system using computer technology. Prior to 1996, the

NLS carried out cadastral survey and land consolidation, produced official mapping, and provided applied services on a reimbursable basis. Local offices of the NLS also conducted cadastral surveys, real estate formation, and land consolidation. Each of 24 counties had a County Survey Authority, which served as links between the central office (since they produced the official maps) and various map users.[18]

Structure and Organization

In 1996, the National Land Survey and the Central Board for Real Estate Data were merged into one organization. This new organization is to provide cadastral, land and GI, and commercial services. Real estate valuation on a reimbursable basis was moved from NLS to a new state company, Swedish Real Estate Valuation Ltd. This new agency was created to facilitate the renewal of cadastral services, to focus on providing information and coordinating the handling of land and GI in Swedish society, to develop businesslike activities, to simplify a complex and expensive administrative structure, and to exploit advances in society.[19]

This agency includes several departments for different activities. The cadastral services department offers supervision and support to new regional Land Survey Authorities. A land and GI services department provides basic land and GI. A third department covers commercial services and provides information services. A research and development department promotes new techniques in geodesy, photogrammetry, cartography, and information technology.[20]

Leadership and Coordination

The department of cadastral services supervises and supports the new regional Land Survey Authorities, and it is expected to support the renewal of the real estate formation process. The Land Survey Authorities are primarily responsible for cadastral services, and they also coordinate on the local and regional levels the updating and use of land and GI. The department of land and GI service is expected to make information accessible, suited to users' needs, and of good quality.[21]

Relationship with the Private Sector

Because the GI functions of the Swedish government were only recently reformed, it is still in a state of transition. However, a predicted outcome of this customer-focused reform is that it will spark increased privatization in Sweden. Real estate valuation – done on a repayment basis –was moved from the National Land Survey into a new government-owned limited company, SVEFA Svensk Fastighetsvordering (Swedish Real Estate Valuation Ltd.). Over 100 NLS real estate valuers have joined the new company, and it is now the largest one of its kind in Sweden.[22]

The department of land and GI services is responsible for such information services as archives, registers, maps, and databases, but it does not produce them. Instead, it purchases the production from Metria, a commercial department or from other providers. This is linked with the government's desire to be primarily a provider of information and a coordinator of providing information in society, in addition to the desire to create competition and lower costs. The government expects that this step will help prepare the commercial part of the organization better for other kinds of commercial services on the market.[23]

Metria, the department of commercial services under Sweden's new system, provides information services including air photography, orthophoto production, maintenance of basic national geodetic networks, and establishment and maintenance of basic geographic databases. Metria also provides services on a repayment basis to municipalities, industry, forestry companies, and utilities. These services include production of large-scale maps and plans, derived maps and database products based on the national map series/fundamental geographic data bases, geodetic measurements and support to GIS users.[24]

Pricing and Intellectual Property Rights

NLS has a turnover rate of about U.S. $200 million, a year. About one third comes from parliamentary funding, one third from fees for official activities, and a final third from charges made for services. NLS' stated financial goal is to reduce parliamentary funding.[25]

Japan[26]

A Geographic Survey Institute (GSI) was established over 100 years ago and remains the focus of GI activities today. GSI originated in the Survey Division of the Ministry of Civil Services in 1869, and, in 1888, an Army Land Survey was established in the General Staff office and carried out the entire fundamental surveying and mapping of Japan. After World War II, GSI was initially housed in the Ministry of Home Affairs, but in 1948, it was transferred to the Ministry of Construction.[27]

Structure and Organization

The Ministry of Construction, through its subordinate Geographical Survey Institute (GSI), is responsible for the country's basic map information, as well as public facilities, such as the nation's roads and rivers. In this endeavor, the Ministry of Construction works closely with a team of other government agencies, such as the Ministry of International Trade and Industry, the Ministry of Home Affairs, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Transport, the National Land Agency, as well as regional public offices. Close cooperation among the different agencies is regarded as imperative.

GSI carries out the following major GI functions:

- **Survey administration:** Under the Survey Act, practically all of the surveying and mapping done by public agencies is controlled by GSI. GSI provides technical assistance and grants permission for surveys to public agencies that plan to produce maps by utilizing the GSI survey results, such as ground control points, bench marks, or aerial photographs. Survey plans are checked, and technical advice is provided in an effort to avoid unnecessary expenditures and to maintain the required accuracy of public surveys. GSI also conducts national examinations for surveyors and assistant surveyors.
- **Establishment and maintenance of geodetic control points:** The GSI establishes and maintains all national control points in order to provide reliable and accurate reference for the horizontal and vertical positions necessary for all the projects related to land such as mapmaking, cadastral surveys, and various public projects. These control points are subjected to re-survey at regular intervals so that accuracy for practical use can be maintained. These periodic surveys provide important information about crustal activities on the Japan Archipelago and its

vicinity and are used in the study of earthquake prediction. GSI also has supported a permanent nationwide GPS network since 1994, resulting in the world's largest GPS array network.

- **Preparation and maintenance of base maps, geographic surveys, and thematic mapping:** GSI prepares and manages Japan's national GI. It prepares and maintains countrywide base topographic maps, along with its geodetic control function. It conducts geographic surveys and thematic mapping, including geographic surveys of major natural disasters, hazard mapping, active faults, volcanoes, and land use.
- **Map information management, and map reproduction and publication:** GSI reproduces and publishes maps, including those that require special reproduction techniques. The GSI offers the public various survey records and results such as tables of control point survey, aerial photographs and maps. Distribution of its end products (paper maps and digital data) is done by the Japan Mapping Center, a quasi-governmental foundation.
- **Research, development and applications of survey technology:** GSI also conducts research and development of surveying and mapping technology using new geodetic techniques that employ space technology and computer-assisted mapping and map digitization; results are made available to the public and distributed internationally.
- **International cooperation in the fields of surveying and mapping:** GSI is also important for international cooperation in the fields of surveying and mapping. Japan is participating in developing international standards through the ISO (International Organization for Standardization) on spatial data. GSI also participates in international conferences and international academic meetings and is responsible for international observation projects, such as Antarctic Exploration, and for technical cooperation with developing countries in the field of surveying and mapping.[28]

Public Purposes

Because Japan is prone to earthquakes, volcanoes, and tsunamis, the national government has historically played a very active role in GI. GSI is a strictly national government organization, thus clearly defining the substantial public purpose associated with GI in Japan.[29]

Leadership and Coordination

In 1995, GSI's lead GI role was expanded to initiate development of a nationwide geographic framework data for areas designated under the Urban Planning Act. GSI has plans for the development of national spatial-data framework throughout Japan and has adopted the following approaches:

- standardizing a spatial data framework in order to ensure efficiency and accessibility in the following areas: (1) the framework itself, (2) the geo-reference systems, and (3) basic GIS software.
- loading existing information, such as that contained in the Housing Lodger and the Construction Work Lodger, for example, into the spatial data framework. In order for such transfers to be done effectively, support between governmental bodies will be necessary. Support to regional public offices in order to improve

their administrative services and to prepare more detailed spatial data is seen as required. Cost-sharing is planned among spatial data framework users, along with financial support from the government.

- building a system of information exchange which will link users and data suppliers in one network. Referred to as "clearinghouse" in western countries, this system is intended to enable users to properly access and utilize spatial data.
- renewing spatial data by modifying or renovating it as the need arises. New road construction and reconstruction, for example, is planned to be reported with speed and a new system to serve that purpose is being developed.[30]

Liaison among government agencies has been established to promote standardization and Japan's NSDI. In 1996, a long-term action plan was adopted that maps out the program into the 21st century. The National Land Agency and GSI serves as the secretariat under the Prime Minister's office to organize research and pilot projects for standardization and to coordinate cooperation among government and private-sector organizations.[31]

Pricing and Intellectual Property Rights

The prices of GSI's products are set and publicized by the Minister of Construction. Revenues are paid to the Exchequer, and they do not accrue to the GSI. The government of Japan is examining issues of copyright law, privacy laws, and regulations regarding fraud with the spatial data in mind. New regulations and standards are being considered to deal with these emerging issues.

Technology

Japanese policy levels contend that the existence of a spatial data framework will, in the foreseeable future, decrease the need for paper; it foresees that information, such as maps or any paper documents, will increasingly be transmitted electronically. However, this shift from paper to electronic transmissions will require a fresh look at the present rules and regulations in this area. New criterion for reading the map – factors such as "precision" and "resolution," – now come into play, replacing factors like "reduced scale."

Relations with the Private Sector

Joint research projects between the research institutes of the Ministry of Construction and the laboratories of private companies are carried out on efficiencies and technological developments in the construction field. One example is a project for the development of standards carried out by GSI in liaison with private companies. Two kinds of standards, a geospatial data transfer standard and geospatial data development standards, are being pursued under a three-year project started in 1996.[32]

OTHER COUNTRIES

While the preceding countries were chosen as representative of major innovators in national approaches to GI policies, organizations, and implementation, some examples of similar changes in addressing GI in other countries are summarized below:

Australia[33]

In Australia, the role of the federal government is considered to be a provider of common, consistent infrastructure for government, the private sector, and community activities. Australia has adopted a metadata standard and the U.S. spatial data transfer standard and works extensively with its private sector in map production. The major government mapping agencies in Australia are the Royal Australia Engineers, Royal Australia Navy Hydrographic Service, and Australian Survey and Land Information Group (AUSLIG), as well as agencies in states and territories. Most states have conducted large- to medium-scale mapping of their jurisdictions, and the national government covers less populated parts of some territories.

The Australian Surveying and Land Information Group (AUSLIG) is a business unit within the Commonwealth Department of Administrative Services of the Australian government. AUSLIG covers surveying, mapping, GISs and consultant services, as well as national mapping, geodetic, remote sensing and land information coordination. It operates the Australian Centre for Remote Sensing (ACRES) and a geodetic observatory.

Coordination of land information policies at the national level is the responsibility of the Australian Land Information Council (ALIC), created in 1986. It comprises the heads of government agencies, who coordinate activity in each jurisdiction. Issues such as pricing, custodianship, data privacy, and data standards are discussed.

Australia is attempting to make a single integrated and homogeneous national spatial database. A first national project towards a national database was to generate a digital mapping base for the Australian Bureau of Statistics (ABS) 1996 Census of Population and Housing. An Intergovernmental Committee of Surveying and Mapping (ICSM) – comprised of the heads of state, territory, and federal government mapping organizations – worked with the ABS to provide a seamless digital map database of Australia. ICSM is currently drafting standards for a national cadastral database and a national topographic data base.

The roles of different mapping agencies in Australia and the relationships between the national government and the states offer another organizational model. The present trend is for the national government to handle policy issues and the states to handle operational issues, such as collection of fundamental data such as geodetic, cadastral, and topographic data.

Russian Federation[34]

GI functions are of particular import in the Russian Federation because of its size. Historically, the state plays a strong role, covering geodesy, cartography, and naming geographical features. Roskartografia, the national mapping organization of Russia, is responsible for revised topographic maps and plans on using digital technology and satellite methods. Surveying and mapping functions considered to be of federal importance include remote sensing, creation and maintenance of federal and regional topographic data archives, development of GISs, standardization, registration, and use of geographic names.

Roskartografia is engaged in a multi-purpose integrated program that is scheduled to be completed in 2000. It aims to eliminate the lag of national surveying and mapping compared with the rest of the world. It will provide for production of maps and formation of digital map archives at federal and regional levels. It includes development of GI for various applications for state government bodies, for national border, and regional, municipal, and territorial jurisdictions.

France[35]

France's National GI Council (CNIG) was established in 1986 to coordinate GI development with a focus on relations between different sectors. These sectors include:

- Service Hydrographique de la Marine, part of the Navy, Ministry of Defense, which is responsible for hydrographic surveys and charts
- Institut Geographique National (IGN), part of the Ministry of Finance, which is the central mapping agency in France with nationwide responsibility for topographic mapping (1:25,000 and larger) and geodetic surveys. The IGN Board of Directors serves as a steering committee for government agencies.

GI is considered to be a basic tool of general government management, rather than involving the private sector extensively. But government funding has been decreasing, and IGN is attempting to increase revenues to cover operating costs. IGN is required to recover at least 50 percent of its operating expenses through the dissemination of information products and services. Cost-recovery policies require that administrators balance their cost-recovery targets with broad public-access goals. Laws on intellectual property and copyright provide a legal framework for defining licensing policies, organizing the distribution of data, and for defining the specifications of data to be supplied, the permitted users, and the inclusion of value-added data. IGN is involved, usually through shareholding, with several state-supported commercial organizations, including IGN International, SPOT Image, and NAVTech/EGT.

Germany

Germany operates on a federal model. The Lander are primarily responsible for geospatial data collection. There are integrated national data sets for topographic data at small scales and a coordination framework for cadastral information. The Lander have responsibility for all data between 1:5000 and 1:1000 scales. The Institute for Applied Geodesy (IAG) does smaller-scale mapping under agreement with the Lander, and counties develop parcel level maps with accuracy of 1:500 to 1:2000. Unlike Sweden, Lander are responsible for the maintenance of land registry. There are links at the national level for data, such as the Statistical Land Related Information System (Statistiches Bodeninformationsytem or STABIS).

Like France, Germany does not have a Freedom of Information Act, and there is copyright protection for government information. The cost-recovery at the Lander level is low (less than 10 percent). The collection and maintenance of geospatial data is mostly publicly funded.

ENDNOTES

[1] A major source for this section is David Rhind, "Chapter 21: Facing the Challenges: Redesigning and Rebuilding Ordnance Survey" in *Framework for the World,* edited by David Rhind (Cambridge, MA: GeoInformation International, 1997).

[2] *Framework for the World, op. cit.*, 278.

[3] David Rhind, "Spatial Databases and Information Policy: A British Perspective", p. 3, in *Proceedings of the Conference on Law and Information Policy for Spatial Databases*, Oct. 28–29, 1994, found at www.spatial.maine.edu/tempe/rhind.html, February 24, 1997.

[4] Ordnance Survey, *Results of the Consultation Exercise on the "National Interests in Mapping"* (London, UK: Ordnance Survey, June, 1996), pp. 5–8.

[5] *Framework for the World, op. cit.*, Chap. 21, p. 299.

[6] *Ibid.*, p. 15.

[7] Rhind, "Spatial Databases and Information Policy: A British Perspective", *op. cit.*, p. 10.

[8] *Ordnance Survey: Annual Report and Accounts - 1996/97* (London, UK: The Stationery Office, 1997). p. 6.

[9] A major source for this section is J. Hugh O'Donnell and Cyril R. Penton , "Chapter 16: Canadian Perspectives on the Future of National Mapping Organizations", in *Framework for the World, op. cit.*

[10] Communication from Tim Evangelatos, Coordinator, Canadian Geospatial Data Infrastructure, Interagency Committee on Geomatics, August 11, 1997.

[11] Briefing to Panel by Dr. John McLaughlin, March 19, 1997.

[12] Department of Natural Resources (NRCan), www.nrcan.gc.ca/home/nrcan.htm, March 6, 1997.

[13] NRCan, Geomatics Canada, Geodetic Survey Division at www.geod.nrcan.gc.ca/html, March 6, 1997.

[14] Evangelatos, *op. cit.*

[15] *Ibid.*

[16] Xavier R. Lopez, "A Comparative Survey of National Information Policies and Their Impact on Access to Spatial Datasets", in *Proceedings of GIS/LIS '96* (ASPRS, 1996).

[17] A major source for this section is Ulf Sangren, "Chapter 18: Merger, Government Firms and Privatization? The New Swedish Approach", in *Framework for the World, op. cit.*

[18] *Ibid.*, pp. 235–7.

[19] *Ibid.*, p. 238.

[20] *Ibid.*, pp. 240–1.

[21] *Ibid.*, p. 241.

[22] *Ibid.*, p. 240.

[23] *Ibid.*, pp. 241–2.

[24] *Ibid.*, p. 242.

[25] *Ibid.*, pp. 244–5.

[26] A major source for this section is Yoshia Warita and Kunio Nonomura, "Chapter 3: The National and Global Activities of the Japanese National Mapping Organization", in *Framework for the World, op. cit.*

[27] *Ibid.*, p. 33.

[28] *Ibid.*, pp. 33–36.

[29] *Ibid.*, p. 32.

[30] Shoji Okuyama and Hiroshi Une, "Establishment of GIS Infrastructure and Related Activities in Japan" in *14th UN Regional Cartographic Conference for Asia and the Pacific* (New York, NY: UNESCO, 1997), pp. 6-8.

[31] Communication with Hiroshi Murakami, Director for Technology Coordination, GSI, September 22, 1997.

[32] *Ibid.*

[33] A major source for this section is Desmond J. Mooney and Donald M. Grant, "Chapter 13, The Australian National Spatial Data Infrastructure", in *Framework for the World, op. cit.*

[34] A major source for this section is Nikolai Zhdanov, "Chapter 6: Mapping in Russia: The Present Stage of Development" in *Framework for the World, op. cit.*

[35] A major source for this section is Jean-Philippe Grelot, "Chapter 17, The French Approach", in *Framework for the World, op. cit.*

APPENDIX G

U.S. Geographic Information Resources Conference

SPONSORED BY THE NATIONAL ACADEMY OF PUBLIC ADMINISTRATION, COSMOS CLUB, JUNE 27–28, 1997

The following documents provide a summary of the four breakout sessions held during the conference. It is a summary document and has omitted detail from the remarks of the guests.

Also attached are remarks by speakers at the conference.

SUMMARY OF BREAKOUT SESSION # 1

The Federal Policy Base And Structure For Geographic Information (GI)

Panel Member: Brad Huther
Facilitator: Roger Sperry
Recorder: Jeff Fitzpatrick

Participants

John Bossler
Susan Carson-Lambert
Charlie Challstrom
Roger Crystal
Alan Dean
Dennis Goreham
Herbert Jasper
Lori Mathieu
John Moeller
Wayne Morrisey
Tom Usselman
Richard Witmer
William Wood

Primary Topics Discussed

- Are the laws, executive orders and other mandates for federal GI activities sufficient and appropriate to meet federal requirements now and in the future and serve as the basis for the National Spatial Data Infrastructure (NSDI)?

- Are there opportunities to consolidate or otherwise restructure federal surveying, mapping and other GI functions to achieve greater economy and performance?
    - If so, which functions should be brought together and how should they be structured?
    - What existing federal roles could be cut back or eliminated with the further development of NSDI and the emergence of greater state, local and private-sector capabilities?
    - Are there actions which could be taken at the field level to better coordinate federal activities with each other, and with state and local governments? Should the field offices take stronger roles in advancing joint efforts on land management, ecosystem management and standards implementation?

Summary

Participants seemed encouraged by the progress being made under the OMB circular creating the FGDC and executive order underpinning the NSDI, and they did not suggest a comprehensive new legislative charter. One participant said more buy-in by stakeholders is needed for any legislative proposal to succeed, and another said there was a risk Congress would make the NSDI "another federal program," whereas a bottoms-up approach is needed. Regarding possible legislation, two issues were identified:

- Assessing the mandates of the four sponsoring agencies
- Means to provide the needed intergovernmental cooperation.

One participant suggested a technique used successfully in other settings of defining the desired goals, then determining what can be accomplished administratively. The rest would be left to legislation. Another thought a champion for legislation in Congress is needed.

It was mentioned that the Government Performance and Results Act may provide a new opportunity for coordinating goals and strategies at the federal level. (The act requires federal agencies to submit strategic plans, including performance measures, by October 1997 and to have annual performance plans by March 1998.) A cross-cutting GPRA plan could be prepared for federal GI activities to provide a better definition of roles and responsibilities. Possibly an informal group of OMB examiners responsible for GI budgets could be formed.

In the context of the policy base, the following comments were made about the FGDC:

- The committee is not an aggressive enough messenger to Congress or the public on the benefits of the NSDI.
- FGDC needs more staff and funding to meet its mandate. Loans of GI agency staff or assignments to FGDC of state and local government personnel under the Intergovernmental Personnel Act are possible sources.
- FGDC might develop and review a common federal budget for federal GI functions and activities.
- State and local governments involved with FGDC could use their contacts with Congress to generate additional support for the NSDI.

- Given that Secretary Bruce Babbitt is committed to staying in office through the second Clinton term, the Interior Department is still the right location for the FGDC and the Secretary the right chair.

As to the opportunity to consolidate or otherwise restructure federal GI functions, the only specific suggestion offered was to bring the Tennessee Valley Authority's mapping functions back to the federal government. Apparently, the TVA board has decided to forego congressional appropriations and operate entirely on self-generated revenues. Therefore, it is unlikely they will be able to keep current the 800 USGS quad sheets for which they are responsible.

In lieu of other consolidations, the group suggested that agencies engage in more cross-servicing. It was pointed out, however, that the proposed Freedom from Government Competition Act now pending before Congress would prohibit cross-servicing by one agency for another when private-sector services are available.

Other discussants also mentioned the desirability of co-locating federal GI offices, such as is now being done by the Forest Service and BLM, in Portland, Oregon. In addition, such activities might be merged with a single agency responsible for management. One example of this is the National Interagency Fire Center in Boise, Idaho, which is staffed by several agencies under the leadership of a BLM executive. Some said federal managers also need greater flexibility to work with counterparts in state and local governments.

To sum up, the group focused principally on (1) ways to strengthen the FGDC by providing additional staff and funding and (2) cross-servicing arrangements, co-location, and multi-agency facilities as ways to improve efficiency.

SUMMARY OF BREAKOUT SESSION # 2

Balancing GI Functions: The Federal, State, Local, and Private Sectors

Panel Member: Terry Keating
Facilitator: Arnold Donahue
Recorder: Bruce McDowell

Participants

Winifred Lyday
Mary Feindt
Margaret Pittman
James Plasker
Doug Richardson
Allen Watkins
Skip Coghlan
Joseph Kuchler
John Palatiello
George Gross
Marilyn Johnson
Don Lauer
John Bossler
Dave Edwards

Primary Topics Discussed

- Should/can there be clear divisions of responsibilities between the federal government, state, regional, county, and city government echelons, and the private sector for specific geographic information functions or for some other framework data type collection (e.g. topography, vegetation, wetlands, cadastre, etc.)?

- What surveying, mapping, and other geographic information activities are so fundamental to governance and public purposes that some level of government should manage them? Which GI activities should appropriately be left to the private sector? Which of these are fundamental to federal government roles and functions?
    - What should be the role of the federal land owners/managers, like Forest Service, BLM, NPS, COE, DOD, etc., in working with sub-federal governments and the private sector on land management functions that require geographic information?
    - What specific criteria should guide the contracting-out of government geographic information functions? What should remain subject to government employee performance? Are there particularly outstanding examples of public/private cooperation/coordination that should be emulated?
- Should all levels of government adopt a uniform approach to access to government geographic information? What should that approach be: Cost of reproduction and dissemination? Plus cost of acquisition/processing? Market pricing? Can a line be drawn on geographic information subject to intellectual property rights/protection?

Summary

Several ways of differentiating GI roles among the levels of government were examined. One was data resolution. The federal government has typically been more interested in low-resolution data, while the local governments need higher-resolution data. The states and counties fall somewhere in between – based on the uses they make of the data.

On close examination, however, these generalizations appeared to be too sweeping. For example, the federal land management agencies frequently need the same high-resolution data that local governments do. All levels of governments need high-resolution property ownership data, and tend to generate duplicate records at great expense. States and regional planning bodies often may use the low-resolution information provided by the federal government. One size does not fit all.

Cost sharing to provide new data at different scales is driven by decision-support needs, but is limited by those specific needs, deadlines, and priorities. There is no general agreement on consistent GI data sets which everyone would view as a fundamental spatial data "infrastructure" that would meet their needs and deserve their proportionate financial underwriting. Land ownership parcels is a basic building block for multi-user GI systems at the local level.

It is easier to aggregate high resolution data into low-resolution data, rather than the other way around. Thus, high resolution data can serve a greater range of needs. It is the common scale found at local levels of government and in federal land management agencies, and increasingly is a scale becoming more readily, frequently, and affordably available from satellite imagery.

Up-dating from governmental transaction files (particularly local files) has potential for generating savings for users. Many local governments may need financial and technical assistance to fully participate in the creation and maintenance of GI that meets national quality standards.

Several different cases of "what works" were examined:

- The National Orthophoto Program (NOP) in which USGS often cost-shares with states or others, and the private sector generally produces the products under contract.
- USGS work with counties is hopeful.
- Cooperation through FGDC is getting things done.
- The NOS "Blue Book" procedure for geodetic points to densify the public survey grid is constructive, although cumbersome. It provides a degree of accuracy that is missing in some systems, such as EPA's GIS which sometimes assigns pollution points to the wrong properties.

The group could not find any way to clearly separate GI functions among the levels of government. Instead, it leaned toward GI consortiums, partnerships, and data linkages.

Regarding public and private roles, the public and private sectors tend to do different things well. For example, the private sector often can acquire and apply new technologies quickly, and offers superior services to the government at lower costs than in-house provision. The private sector, however, favors copyrighting data to protect future profits, so it is not as good at providing open access to GI data and products.

Government is better at providing open access to data and taking on stewardship responsibility for historical data and long-term storage of official records. However, government is slow to hire needed expertise and purchase new technologies. Sometimes governments also are slow to change the laws under which they operate, and they may perpetuate obsolete services or fail to keep up with current trends.

The federal government has historically performed some unique GI functions. Without the federal government, the Nation would not have the public land survey system, geodetic control, TIGER files, the Internet, the global positioning system, and digital imaging. These functions have been invaluable to the Nation's economy, and have enabled many new commercial enterprises to spin off. The role of CRADAs in maintaining this federal innovation function was mentioned. Current federal statutes require the agencies to encourage commercial spin-offs. Important public purposes should provide the context for private roles in GI.

Concern was expressed about the pending WIPO treaty on copyrighting data bases for 25 year periods. It could have a chilling effect on data sharing and on open information practices in the U.S.

In the U.S., governments have a responsibility to make their data openly available to the public. The form of these data was debated. Some believed that these data should be processed enough to make it relatively easy to use. Others felt that this would be providing the "value added" features that should be provided by the private sector for a fee, even if doing so might reduce the uses of these government-produced data.

It was agreed that outsourcing to the private sector should be used to reduce public costs, when that would be the case, but there was divided opinion about the proposition that any time the governmental data have market value, they should be turned over to the private sector to serve the market. The practice of selling advertising space on government produced navigation charts was questioned by some as crossing the line between the public and private sectors.

The line between making public data widely available and expanding the commercial markets for value added GI products was not clearly defined by the group. Nevertheless, it was recognized that this could become a bigger problem in the future as very large firms get into this field.

There was considerable sentiment among the public sector representatives in the workshop that their agencies needed to perform enough of their functions themselves to maintain their expertise, remain familiar with current costs as a basis for contracting-out, and hold contractors accountable for producing quality data.

SUMMARY OF BREAKOUT SESSION #3

Coordination, Collaboration, and Partnerships

Panel Member: Jonathan Howes
Facilitator: Rebecca Wallace
Recorder: Lisa Warnecke

Participants

Mark Schultz
Roberta Quigley
E. Tim Smith
Gary Caswell
Kathy Clement
Annette Krygiel
Pat Garvey
Richard Hogan
Karen Siderlis
P. Patrick Leahy
Glen Boledovich
Larry Sugarbaker
Gale TeSelle
Gene Thorley
Russ Brodie
Henry Tom
Ronnie Taylor
Jerry Dobson

Primary Topics Discussed

- What are the emerging roles for the FGDC to accomplish in terms of interagency federal GI coordination? What additional approaches should the FGDC use to accomplish these and/or existing roles?
- Should the FGDC be modified or strengthened? If so, how?
- How can the standards-setting process be improved to achieve more timely and widely accepted results that will enhance the NSDI?
- Should state and local governments be given more responsibility for enhancing the NSDI? If so, in what ways and how should such responsibilities be funded?
- How can the private sector be made a more active participant in fashioning the standards, framework, content and standards of the NSDI?
- Should interagency federal GI coordination be strengthened beyond current lev-

els? If so how? Are there approaches and mechanisms that could help in addition to FGDC?

- Should there be additional guidance, technical assistance, incentives or oversight of federal agencies regarding GI coordination, FGDC involvement, standards compliance or other aspects of GI?
- How have partnerships worked so far as a means of sharing tasks and developing the NSDI? Where have partnerships worked well, been disappointing, or failed altogether? What changes are needed to make partnerships easier to create and work better?
- What authorities, responsibilities and resources should field-level federal agencies have in order to better partner with other federal agencies, states and localities?
- What steps or approaches would improve coordination on the NSDI among federal, state, and local governments, as well as the private sector and academia? What about coordination among federal agencies at either the headquarters or field levels?

Summary

An overall theme was that better articulation is needed of the vision, objective and implementation plan for NSDI, particularly for individual federal agencies and the federal government as a whole, which would improve the chances of getting others to "buy in."

- Participants agreed that six or seven test cases are needed to examine partnerships. While some have been studied, they need more structure, should be "place-based" and involve all sectors. The cases should investigate goals and objectives, outcome, existence and relevance of leadership, quantify benefits, what does and does not work to determine models, how to sustain partnerships, and identify a compelling case to push the proponency and terms of engagement for partnerships. The economic aspects of partnerships should be examined to determine investments, expenditures and economic value.
- The group was divided as to whether there are enough money and resources now to form partnerships and to accomplish NSDI. Some attendees feel there is enough money available as evidenced by all the redundant data development (e.g., the Clark County, Ohio example described by John Bossler in opening remarks).
- There was some consensus that there needs to be some (financial or other) incentives for the parties concerned to form partnerships. One opposing view was that if the parties understand their roles in and the benefits of a partnership, they should naturally want to partner and should not need incentives.
- NSDI should be elevated to a policy level to be evaluated as an enterprise-wide function like infrastructure (e.g., National Highway System). Like other infrastructures, NSDI requires a large coordinated investment. Other infrastructure investments should be investigated to see how they were accomplished, and other industries and countries should be studied to determine models. NSDI also needs to be better articulated and advocated to show how it aids in meeting agency missions.
- It was agreed that many sectors, particularly state and local governments, share responsibility for NDSI and need to be involved in NSDI coordination at the

national level, recognizing that (1) FGDC is being expanded to include one state and one local member, and (2) that FGDC has initiated a "stakeholders consortia" (yet unnamed) including these two sectors, as well as academia and the private sector. There was some discussion to avoid use of the term "federal", and perhaps it should be replaced by "national" in FGDC. But participants did not want FGDC's primary role of federal interagency relations to be diluted with the increased involvement of other sectors.

- Needed national and government-wide leadership and coordination roles were discussed at length. FGDC is a good coordinator and facilitator of dialogue, etc. Its successes should be recognized and marketed. These roles are on one end of a continuum, but more proactive monitoring and oversight roles have a further potential to get individual federal agencies to better implement NSDI approaches, FGDC standards, etc.. Perhaps the FGDC is not the right entity for them because it would not want to jeopardize their progress, and these roles could be the responsibility of a program in a line agency. Possible roles include (though the need for some of them were debated):
    - Advocate partnerships.
    - Identify and work to eliminate disincentives for partnerships within individual federal agencies.
    - Be proactive with broader efforts, e.g., those implementing GPRA and ITMRA at the government-wide and agency level, forge relationship with and advise the CIOs Council.
    - Be more proactive to fund, create, maintain and establish custodianship for specific data. Could inventorying existing and planned data efforts within federal agencies identify common interests and needs, pending and future expenditures and future schedules? This information could be made available to naturally stimulate partnerships, and/or the entity could aggressively get the sets of two or three agencies with leading efforts for obtaining specific data to combine and synchronize forces. There could be solicitation funds to further develop these data to make them of use to others if warranted. Also there could be identification of national data needs after this inventory, and determination of responsibilities and funding to meet and maintain them. These efforts would provide a unified rather than redundant or conflicting federal position allowing work with states and locals. Perhaps the entity could have its own funding to supplement or stimulate such efforts.
    - Establish one or more roles with OMB, such as providing input on agency GI budgets, recommending cross-cutting initiatives for data development and maintenance.
- An alternative perspective should be considered in NSDI. It has been a federal approach, with increasing state, local and other input. Alternatively is the "lowest common denominator" approach since data developed at the local level can be aggregated up to state and national levels, but cannot be done "top-down". For example, if this perspective had been used to determine FGDC's "Framework" data categories, utilities or rights-of-way would have been one of the priority layers rather than the current street centerline which has marginal local value and can not be disaggregated for local use.

- This local perspective would help to get commitment and use of standards by these local and state governments. Such state and local commitment to implement standards is needed up front, but states and locals have their own authority to determine whether they will comply with these standards, not that of the federal government.
- Examples were heard of how state-based partnerships work, particularly since tentacles exist between federal and state agencies for specific missions, and also between state and local governments. For example, it was stated that Florida saved $28 million from federal and state agencies pooling their funds together at the state level to collaborate in data development.
- Federal field offices need more authority, flexibility and resources to form partnerships or need to better use the authority they have. FGDC should establish and facilitate a federal interagency group within each state. These groups should link with state GI councils and the two entities then should address standards within the state among state, local and federal agencies and others. The chairs of these state-based federal interagency groups should participate as the field representatives to FGDC at the Washington level.

SUMMARY OF BREAKOUT SESSION # 4

Taking Advantage of Emerging GI Technology

Facilitator: Bob Chartrand
Recorder: Daniel Stearns

Participants

Dan Cotter
Gladys Cotter
Gayle Gordon
Millington Lockwood
Anne Hale-Miglarese
David Meir
Harland Onsrud
Fred Ris
Walter Senus

Primary Topics Discussed

- What major technologies are driving geographic information today? How are they likely to evolve in the future? What is the future technology outlook in collection, processing, and other areas, such as remote sensing and satellite collection technologies, GPS, GI processing and data integration, communications technologies, display and presentation technologies, advanced applications and new storage and/or media distribution?
- What areas of GI technology development that serve governmental needs merit dedicated or concentrated governmental support, encouragement, or funding? Which areas are well served by the private sector/
- Are current government arrangements, such as CRADAs, NASA CANs and other cooperative agreements meeting government needs well? Are government GI developments well-coordinated?
- What potential problems and/or pitfalls do new technologies raise for geographic information? How serious are the problems of privacy, confidentiality, and data security/integrity? What role should the government play in addressing these problems?

- What developments are needed to make GIS more user-friendly? Less costly? What are the prospects for these developments and what impact will they have?

Summary

In developing its series of topical highlights and issues for further consideration by the project oversight Panel, this discussion group focused throughout on the utilization of advanced GIS technologies by government at all levels: in terms of activities solely within the purview of these entities, when featured in a partnership action environment, or as the result of activities fostered by a governmental component. It was recognized that there often are significant difficulties in orienting responsible political support groups in order that they may fully understand the value of utilizing, and the necessity of appropriately funding, such tools and techniques.

The following consensus recommendations reflect the priority candidate areas for inclusion in the project report.

- More definitive reviews of user requirements are needed for all government entities – Federal, state, local – responsible for collecting Geographic Information.
- Enhanced methods of achieving "public participation" should be evolved, in order to incorporate such findings (and needs) into the process of GIS collection, analysis, and utilization.
- Development of standards for data certifiability, in order to optimize their use, include these key considerations:
    - What does "quality of data" really mean?
    - Explore the value of technological means (such as "data visualization of error") in improving data usability.
    - In what ways can governmental units gainfully exploit such advanced tools and techniques?
- The employment of man-machine techniques to delineate data quality should be optimized.
- Digital image processes need to be developed which have a further potential for extracting useful information (e. g., automatic feature identification and extraction).
- Multi-level security, always a critical factor, is an "enabling technology" as regards the effective use of GIS, and should be developed best through public-private sector collaboration.
- The Federal Government should pursue the development and validation of inexpensive technologies to support GI collection; e. g., aircraft platforms (U-2, SR-71) vis-a-vis satellites, digital video (mounted on surrogate data collectors, and LIDAR).
- A priority effort should be initiated to identify the ways in which technology can facilitate improved taxonomic definitions, thus expediting user recovery.
- "Multi-sensor fusion," as a discipline, will result in improved analytical products; such processes are candidates for governmental initiatives which can lead to heightened operational effectiveness.
- Further study should be undertaken to determine to what extent technology can assist in the data certification process.

- There is a critical need for management, as well as operational cadre at all levels, to understand the necessity for the training/retraining required in technological systems' replacement.
- For the time being, governmental storage and media distribution capabilities will depend on – and be driven by – identifiable consumer trends (i. e., "the marketplace").

CONFERENCE SPEAKERS

Keynote Speaker and Respondents

Mark Schaefer, Acting Assistant Secretary, Water Resources and Science, U.S. Department of the Interior.

"Thank you for inviting me to join you today as you consider the future of the institutions and practices by which we produce, use, and share geographic information. As you may be aware, Secretary Babbitt believes that geographic information is critical to the sound operation of government. Geographic data and geospatial technologies will help us address the scientific issues facing the nation more efficiently and effectively. The secretary views geographic information as a resource to be shared and wisely used throughout our society to help achieve a sustainable economy, protect the environment, and enhance our well-being.

"Likewise, I am convinced of the need to move steadily forward in the implementation of the National Spatial Data Infrastructure (NSDI), and to evolve the NSDI so that it serves not just the federal government but state, local, and tribal governments, the private sector, and the academic community as well."

What is the National Spatial Data Infrastructure?

"In the abstract, the NSDI can be seen as technologies, policies, standards, and human resources. It was defined this way in Executive Order 12906. In its implementation, the NSDI is a series of actions and activities that encompass forming partnerships, collecting metadata, establishing clearinghouses, agreeing on data standards, and developing a framework of basic data. As a system, the NSDI can be viewed as a constantly evolving network of technologies, institutions, relationships, collaborations and social and economic influences.

"In reality, the NSDI is all of these and more, but the following common ideas tie together its many facets:

"The NSDI is:

- "organizations and individuals cooperating
- "using electronic technology to help access and share geographic information
- "following mutually accepted standards
- "developing common base themes of data

so that together we can create networks of organizations and unified collections of data for decision making and scientific purposes.

"For me, NSDI has very practical applications. NSDI will improve our ability to use the tools of geographic analysis such as software, laptops, personal computers and decision support systems to help citizens gain knowledge of and become involved in decisions that affect their communities. In this view, the NSDI helps to evolve these tools as 'Jeffersonian technologies' for the benefit of all."

How Is NSDI Advancing?

"**No one is in charge.** This does not mean that no one has responsibility, but rather that all sectors play a role in the NSDI and share responsibility for its success –we are working through consensus, collaboration, and partnering.

"**Relationships change.** The roles and relationships of stakeholders are constantly shifting as technologies, institutions and economies change.

"**Place matters.** The primary emphasis of the NSDI is on 'place' and improved decision making by community stakeholders over a given piece of geography. The NSDI can thus be seen as complementary to recommendations of the Presidents Council on Sustainable Development and to other place-based initiatives.

"**It's good business.** NSDI relies on the cooperation and participation of stakeholders through good business practices and enlightened self interest.

"**Leadership is crucial.** Leadership within the federal community is facilitated by the Federal Geographic Data Committee with an active cabinet officer as the chair and with active agency representatives as members of the Steering Committee. Secretary Babbitt's role and interest have increased the visibility of the NSDI and the FGDC. Cabinet officials are not likely to be engaged if leadership responsibility is lodged in the Office of Science and Technology Policy or a similar organization that does not have line management responsibilities. For example, the National Science and Technology Council does not have funding for any actions except through agency contributions.

"**The best data are local.** The highest-resolution, most accurate data are generally collected and maintained at the local level. National activities should enhance and strengthen, rather than attempt to duplicate, these already considerable investments, and attempt to leverage local efforts.

"**Recognizing the importance of the private sector.** The private sector has an important role which could also be affected by larger information issues such as database protection, privacy liability, and telecommunications policy.

"**Research and education are fundamental.** For the NSDI to evolve into the future, research and education are important. The academic community plays a role here, as well as in policy analysis.

"**Critical importance.** NSDI activities are not glitzy or high profile but are critically important for science and decison-making."

The Role and Effectiveness of the Federal Geographic Data Committee

"The FGDC process is one we believe to be effective, even without legislation or a 'big stick' approach to discipline. More clout or control does not necessarily mean more effectiveness or cooperation. In today's atmosphere, the command and control approach is of limited use. Experience has shown that people cooperate best when they choose to be involved because of mutual interest.

"Effective leadership, vision, and enough resources to project the vision, create a strong process. It has been argued that the FGDC process will be in danger if Secretary Babbitt leaves. We contend that organized NSDI activity had already begun as part of the National Performance Review before Secretary Babbitt became chair. For example, the executive order and the metadata standard were in place. We feel we are institutionalizing the NSDI and working to make it important regardless of the roles of individuals or the views of different administrations.

"A potential danger is the lack of support from within federal organizations and the possibility that OMB Circular A-16 could be abolished. OMB Circular A-16 has been in place since 1953 because it is good government. We believe that FGDC and the NSDI are gaining support and acceptance as 'good government and good business practice.' This acceptance will help sustain the NSDI and also reduce the reliance on individuals.

"It has been said that the coordinating process could be improved if a 'strong' national body were created through legislation. On the surface this sounds attractive, but given today's climate, can we be sure of the outcome of any legislation? I question whether organizations would really respond to a legislatively designated body such as a commission or council that told them what they must or must not do, or whether or not they would be permitted to pursue a need for a particular type of data. Central control is not the way we are managing our governmental activities and to advocate that approach for spatial data while at the same time preaching empowerment and devolution, will not bring us the progress we all want to see."

Funding for NSDI and the FGDC

"The National Performance Review recommended that $6 million be added to the existing resources available FGDC coordination activities. This has resulted in approximately $7.2 million a year being allocated to the FGDC and to other USGS activities in support of the NSDI. Some of these funds have been used to support the FGDC Secretariat staff that is the focal point for coordination, facilitation, and support of NSDI. The bulk of the funds are used for cooperative programs in the community, for framework activities, clearinghouse and metadata implementation, and training,. These funds provide limited support for standards activities and also are used to develop partnerships.

"Our intent is to maintain funding for the FGDC activities so that we may continue to provide coordination and facilitation support, provide funds for initiatives and seed projects, and support high priority developmental activities. In addition, we'd like to find ways to leverage program funds within federal agencies to support the NSDI. Agencies spend substantial funds for data collection, development, and use. These funds are currently not specifically tied to NSDI but might provide a means to 'flesh out' the data resources of the NSDI, along with similar mission funding from state and local governments. These funds need to remain tied to specific missions and programs in order to address data, personnel, research, equipment and other needs. But organizations at all levels of government are concerned about the bottom line, and have expressed interest in finding ways to better leverage program funds so they contribute more consistently and in a timely fashion to the NSDI.

"Could we use more funding to aid the FGDC and NSDI activities? Yes, but remember a fundamental premise of current government direction and of the NSDI–we must make better use of past, current and future investments. This is as true for geospatial data as it is in any other area. If added funding is provided it should not be at the expense of any effective data program and should be aimed at improving operations across government and other sectors."

The NSDI Strategy

"'A Strategy for the NSDI' lays out a vision: 'Current and accurate geospatial data will be readily available to contribute locally, nationally, and globally to economic growth, environmental quality and stability, and social progress.' It also identifies four goals for the NSDI as a whole:

- "Increase the awareness and understanding of the vision, concepts, and benefits of the NSDI through outreach and education.
- "Develop common solutions for discovery, access, and use of geospatial data in response to the needs of diverse communities. This includes metadata tools, clearinghouse, decision support systems and interoperability of hardware and software systems.
- "Use community-based approaches to develop and maintain common collections of geospatial data for sound decision-making. Examples of coordinated data collection activities are the DOI High Priority Data Initiative and the Digital Orthoimagery Program
- "Build relationships among organizations to support the continuing development of the NSDI.

"The strategy was developed from an initial NSDI plan of 1994 with the involvement of a broad segment of the geospatial data community. The 1994 plan focused on specific actions for getting started with the NSDI and much of the activity was, by necessity, federally oriented. The revised strategy includes broad goals in order to be inclusive.

"Impetus for revising the strategy came from a meeting on the future of spatial data and society sponsored by the Mapping Science Committee of the National Academy of Science, National Research Council in April 1996. This meeting provided input on strategies and actions to advance the NSDI. A 'Town Meeting' on the NSDI was held as part of the of the Urban and Regional Information Systems Association convention in Salt Lake City in the summer of 1996. That meeting gave further shape to the revision effort. A draft for a new strategic plan was developed and reviewed by the FGDC Steering Committee that fall. Secretary Babbitt and the Committee enthusiastically endorsed the direction of the strategy and encouraged the input, ideas, and participation of others. A public review period followed during which comments were solicited from a number of organizations such as the Mapping Science Committee (MSC), the National States Geographic Information Council, the National Association of Counties, the Open GIS Consortium, professional societies, and federal agencies.

"An open public meeting, attended by individuals from all segments of the geospatial data community was held to discuss the comments received during the public review and agree on goals and objectives. This meeting resulted in material that formed the final draft of the strategy. The final strategy was printed and issued in April 1997. Copies are available and all organizations are encouraged to use it as an aid and guide in developing tactical or implementation plans."

Organizations From All Sectors Are Implementing the Strategic Plan

"'A Strategy for the NSDI' provides a structure and overarching view under which individual organizations develop tactical or implementation plans that suit their particular situations and geographies. Sectors are working together to stimulate initiatives and networks where needed."

Stakeholder Support of Strategy Is Crucial

"A goal of the strategy is to build relationships among organizations to support the continued development of the NSDI. Two objectives under this goal describe desirable outcomes: develop a process that allows stakeholders to define logical and complimentary roles in support of the NSDI, and 'build a network of organizations linked through commitment to common interests within the context of the NSDI.'

"This initiative involves advocates from several sectors. So far three, inter-sector meetings have been held that have drawn together federal agencies, represented by the FGDC; with states, represented by the National States Geographic Information Councils (NSGIC); local governments, represented by the National Association of Counties; the private sector, represented by the Open GIS Consortium, and the academic community, represented by the University Consortium for Geographic Information Science (UCGIS). This initiative focuses on 'value added' activities of inter-sector interrelationships. It is an open-ended process that attempts to keep broadening participation to more organizations in the sectors mentioned above as well as cities, municipalities, non-profit organizations, and tribal governments."

Active Participation By Stakeholders in Strategy Implementation

"At the April 30, 1997 FGDC Steering Committee Meeting state and local representatives met with the FGDC Steering Committee. Attendance included representatives from 18 state geographic data councils, NACo, and NSGIC, along with representatives from the private sector, academic and the National League of Cities. Representatives of states and counties lead the discussion of issues of concern to them: identification of opportunities to leverage existing programs, ways to improve participation of federal field offices in NSDI, and participation of state and local representatives in standards development. Actions were identified to address these areas, and activity is ongoing.
Strategy implementation in federal agencies

"The FGDC subcommittees and working groups focused their 1997 work plans, and will focus the plans of subsequent years, towards implementing the strategy. Federal agencies are beginning to develop plans to implement the strategy. For example, Tom

Hebert of the U.S. Department of Agriculture presented an NSDI strategy plan for USDA implementation in December of 1996. Dianna Josephson has taken a lead in Commerce to champion the strategy in that Department and particularly in the National Oceanic and Atmospheric Administration. We are implementing the NSDI Strategy across the Department of Interior. For example, the U.S. Geological Survey has revitalized its NSDI implementation and Director Eaton charged his Division Chiefs with leadership roles in NSDI development. The Fish and Wildlife Service is serving a large quantity of data, particularly National Wetlands Data."

Continuing Progress in Other Areas

"While making the NSDI more robust is a huge task and much remains to be done, there are many signs of continuing progress:

"**Metadata.** FGDC has endorsed a standard and is in process of refining it This standard is greatly influencing the ISO Metadata Standard. A multi-sector team sponsored by the FGDC is working to support the development of US input into ISO.

"**Clearinghouse.** The NSDI Clearinghouse is operational and growing. We now have a Clearinghouse mechanism with spatial search capability that allows users to search remote sites on the Internet for particular metadata fields, such as title or date of publication. The Clearinghouse provides metadata records of data sets for users to browse and in some cases, where organizations have data online, users can download data directly through the clearinghouse.

"**Standards.** Approximately twenty standards are under development. Participation by state and local governments, academia and the private sector in the standards process is growing. To date standards for metadata, cadastral data, wetlands data, and the Spatial Data Transfer Standard (SDTS) have been approved by the FGDC. Standards for vegetation and a point profile for SDTS are soon to be approved. Public reviews are in progress or recently completed for soils data, accuracy standards, orthoimagery, and elevation data.

"**Framework.** The FGDC has provided funds to NSGIC to survey framework data holdings at state and local levels. The survey is currently in progress and will give us a better handle on who has data that can be used in the framework and how we can bring this data together.

"**NSDI Partnership Funding Programs.** Interest in these programs remains high and these programs will be offered again next year. They provide 'seed' funding to support activities in the geospatial data community that will stimulate NSDI implementation. The Cooperative Agreements Program (CAP) has focused on metadata and clearinghouse implementations in non-federal organizations. In its four years, this program has supported hundreds of projects, and touched thousands of organizations through its cooperation and partnership requirement. The Framework Demonstration Project Program (FDPP) is designed to provide funding support to partnership activities for exploring the development of the NSDI framework. The program encourages a variety of framework activities and has stimulated a number of very interesting projects that will provide valuable information about implementation of the framework. The NSDI Benefits program provides funding to examine some of the uses of NSDI and data generated from NSDI activities. The focus of this program has been on federal agencies with a requirement that the project be partnership based. This is the first year for this program which evolved from an initiative to support a wide range of activities in the Greater Yellowstone area involving National Park Service, the U.S. Forest Service, universities, states, counties and towns. All of these programs link activities and practices of the NSDI to other data programs and initiatives. In a growing number of cases, projects are beginning to implement the NSDI simply because they recognize this as a good way of doing business."

The Global Spatial Data Infrastructure – An Emerging Issue

"The need to address a Global Spatial Data Infrastructure (GSDI) is emerging. There are a number of 'grass roots' efforts to develop spatial data infrastructures throughout the world. It may be that the potential for a GSDI may best be discussed through established and emerging regional coordination structures such as EUROGI, the committee for GIS infrastructure for Asia and the Pacific, or the proposed permanent committee for the Americas. These regional structures are increasingly made up of representatives of nations with their own internal spatial data infrastructures. Meetings such as those scheduled in Chapel Hill (1997) and Ottawa (1998) will help define common issues, needs and opportunities. Although it is still too early to define the structure desirable for a GSDI, there are a number of common interests that can be worked on now."

A View of the Future

"Imagine a future in which decision makers at all levels are informed by widely available scientific and other data.

"Imagine a future in which the public contributes to, uses, and serves as stewards of the information commons.

"Imagine a future in which school children are building databases that allow them to learn more about the world in which they live.

"Imagine a future in which an information commons help facilitate communication and collaborative decision-making.

"Imagine a future city council meeting which farmers' agricultural water needs, and the requirements of urban and suburban residents for water for domestic uses can be discussed with federal water managers and with state and local officials. Geographic information is used to display issues, alternatives, probable impacts, and finally to help reach an agreement on a solution that best meets the collective need of those affected.

"This is the NSDI in action - in use for the citizens of this country to aid in building sustainable communities."

What Does This Mean?

- "The NSDI strategy is sound.
- "We need to accelerate metadata, clearinghouse and coordinated collection of framework data.
- "The process of discussing and defining stakeholder roles should continue.

- "FGDC should continue to play the role of facilitator and national level focal point.
- "The federal role should emphasize responsibility for standards in mission areas, data collection and production where data to support federal science or decision needs or national programs is not elsewhere available. This role also should emphasize the integration of data from various sources to provide regional or national perspectives or products.
- "We are making significant progress and with the help of the NAPA Study Panel and the wise thoughts and contributions of this audience I believe we will be positioned to achieve the future I described and the vision of the NSDI: ' Current and accurate geospatial data will be readily available to contribute locally, nationally and globally to economic growth, environmental quality and stability, and social progress.' "

Terry Keating, President of Lucerne International, Member of the Academy Panel on GI Resources

Terry Keating provided additional comments in response to Schaefer's remarks and gave his views on the future of GI activities in the US. His background in GI includes membership on the NRC Mapping Sciences Committee and membership in the Management Association for Private Photogrammetric Surveyors (MAPPS). He is also a panel member for the Academy study.

He focused his remarks toward leadership and coordination of the NSDI. He began by asking "Where are we?" and "Where do we need to go?" He cited the social changes (demographics, infrastructure, global interdependence, privacy), governmental trends (devolution, decentralization, public access, deregulation, commercialization), technology advancements (sensors, communication, GPS, storage, processing), and the information age (multimedia, Internet, datastores, access) as major forces that shape our environment. They are all changing. So, too, are the maps and associated data changing.

He noted how spatial data are becoming assimilated into mainstream information management policy. Pre-packaged spatial data are also becoming a commodity. Just-in-time mapping is becoming a reality, the images are available, and will be going on-line very soon.

He described the changes underway at the USGS National Mapping Program. The federal government has transitioned from primary producer to federal integrator responsible for select framework categories. Largely in-house activities have been contracted out, leaving only a small amount of in-house capabilities. Cartographers now have to practice integrated skills in contract management such as quality assurance and quality control. Quad-based paper maps changed to user-defined content and former map warehouses now provide maps on demand and serve as business partners.

He talked about the importance of GI economically, noting the large amounts of money surrounding GI activities. He stated that geographic information plays an economic role in about 50 percent of activities of the US gross domestic product (taxation, transportation, land management, environment, construction, emergency management, defense). Given this environment, he suggested that organizational policies should probably change as well. The central question here is "from what to what?"

Keating suggested that structure and organization needs to switch from a 'Federal' mandate to a 'National' perspective. This will require representation from all levels of local, regional, tribal, state and federal government and include utilities, academia, and private sector producers and users. Moreover, agencies involved with national defense will need to be involved. The financial community and international interests will also need to be involved.

He described the evolution from a strong 'Committee' to a funded 'Program'. Keating said a statutory charter with formal authority needed to be enacted. Also, a shared vision regarding geographic information needs to be developed.

He underscored the need for continuity of leadership and for having a budget with oversight authority, and accountability. Voluntary cooperation will no longer be adequate to get to an NSDI. 'Interagency Cooperation' needs to be replaced by an 'Integrated Vision'. The integrated vision will require revision of agency-specific missions to reflect an integrated approach. Ground rules need to be defined for allocating data stewardship (collection, maintenance and access). Schedules and objectives need to be synchronized and information policies need to be linked to management agencies.

He described his view of how one-on-one 'Partnerships' to could evolve to broad 'Consortiums'. These consortiums will involve the formation of data utilities, the division of responsibility for geographic information functions, the development of common data that benefit multiple users, an allocation of framework data stewardship to various constituents and building relationships among organizations.

Keating then laid out how GI should transition from a 'Government Responsibility' to a 'Business Opportunity'. NSDI could evolve funded, with private-sector initiatives. Roles and responsibilities will need to be defined in advance. Customers will drive the initiative and marketing will make NSDI stronger.

Keating suggested that this model would require appropriate oversight from an appropriate source.

To get to this vision structure will need to change from 'Centralized' control to 'Community-based Responsibility'. This will happen for a variety of reasons. Federal budgets are insufficient to maintain current maps, maintenance of data is local business, and transaction-oriented, on-line spatial management is increasingly available.

Keating suggested that 'Standard Formats' will need to change to 'Rules of Access'. He proposed that the GI community adopt the Open GIS Consortium approach of rules of access that set broad parameters for data collection and maintenance. Rules of access will avoid the current need for re-formatting to a common file structure. He encouraged the support geo-libraries and clearinghouses approach.

He concluded by asking "Where do we go from here?" He noted that federal agency budgets cannot afford to collect spatial data at the levels of detail and accuracy required by state and local users. State, local and private users, on the other hand, can collect levels of data that perhaps can be generalized for use by the federal agencies. A strategy is needed where local and private data producers receive benefits in exchange for facilitating and guaranteeing agencies ready access to locally maintained data. Getting from here to there is the challenge. The Academy study is only a start.

John Bossler, Director of the Center for Mapping at Ohio State University

John Bossler agreed with the characterizations and pronouncements made by previous speakers and reinforced the importance of coordination of efforts as one of the highest priorities of the GI community. He referenced two projects conducted by the Center for Mapping of the Ohio State University (OSU) regarding geographic information to illustrate specific coordination needs and opportunities.

The first project was an investigation of the research practices and needs of eight federal agencies. Researchers identified a significant degree of research duplication and lack of coordination among the surveyed agencies. Moreover, the agencies had a number of the same research needs. He said this suggests a greater role for the FGDC in coordination, such as encouraging and providing a mechanism for the pooling of funding for common research tasks. Bossler concluded that significant improvements could be made to satisfy related research needs, and in turn, enhance federal productivity. He said that the FGDC holds many of the keys to greater coordination of research efforts that can aid several federal and other organizations.

Dr. Bossler also cited the Center for Mapping's GPSVan project in Clark County, Ohio, where personnel from the Center drove and surveyed all the roads in the county using vans equipped with cameras and GPS receivers. Because the imagery is taken in stereo pairs with digital cameras and is integrated with the GPS, it is simple to obtain highly accurate coordinates of objects of interest to highway engineers, e.g., guard rails, signs, railroad crossings, etc. while driving at normal speeds. The GPSVan also captures continuous coordinates of the road centerline and edges. These road data are valuable for numerous purposes to several organizations.

He said that during the course of the Clark County project, participants discovered that digital road and roadway data are being collected by many different public and private organizations on different time schedules, to different accuracies (sub-meter to 30 meters), and at varying degrees of completeness. They concluded that, over time, at least eight different organizations had collected data about the roads in Clark County, and all of them had similarly captured centerline data.

These uncoordinated data acquisition efforts, which typically are conducted in many parts of the country, make it extremely difficult to share digital road data. This, in turn, results in extraordinary duplication of effort, which also means that separate datasets must be separately maintained. Public data are typically collected in legacy fashion with independent, closed systems, and private data vendors focus primarily on metropolitan areas. Therefore, many data users find it difficult to acquire existing datasets that meet their needs. Users often digitize paper maps (which are out of date, incomplete, and inaccurate) or engage in expensive primary data acquisition. Users may acquire digital maps from federal sources (e.g. USGS for 7.5" quadrangles, or the Census Bureau for TIGER); however, these sources may not contain current information or meet accuracy requirements.

To reduce the nation's investment in roadway mapping requires a combination of advanced technology and new organizational funding mechanisms. For example, a government consortium could be formed by the FGDC to cost-share the application of vehicle-based, GPS mapping technology such as the GPSVan developed at OSU. This technology can gather three-dimensional coordinates of all significant road and roadway structures and create a current, accurate (submeter), digital map of the nation's roadways. A digital map, of the kind contemplated here, could be used in numerous national initiatives including ISTEA (Intermodal Surface Transportation Efficiency Act), ITS (Intelligent Transportation Systems), and the NSDI (National Spatial Data Infrastructure). Moreover, this digital map of the nation's roads could be made available to any user (public or private) at the marginal cost of reproduction for use as a layer in any GIS application. Clearly, users will add value by gathering additional data to meet specialized needs, but at a lower overall cost than the status quo.

Dr. Bossler stated that there are approximately 3.9 million miles of roads in the United States. He estimated that vehicle-based, GPS mapping technology can provide accurate (submeter) road centerline data at a cost of $35 per mile. Digital imagery and analog video can be collected for an additional $15 per mile. The imagery could be made available to users for additional processing to gather coordinates of additional infrastructure features (e.g., telephone poles, fire hydrants, etc.).

Dr. Bossler said he and his colleagues estimate that road centerline data and geo referenced imagery (i.e., images assigned a latitude, longitude, and geometric height) could be provided for the entire nation at a cost of $195 million (e.g., 3.9 million miles @ $50 per mile). While this is a significant outlay, these data would be collected only once, in digital form, and could be easily transferred to any user in the country. This would provide huge savings to the federal government and the NSDI in general. Dr. Bossler stated that Al Watkins of SAIC (former chief of USGS's National Mapping Division) has suggested that a case study should be performed about Clark County and other localities. While this is an outstanding idea, he said this would require significant resources.

Dr. Bossler concluded by stating that these projects illustrate and underscore the inefficiency resulting from a lack of national coordination regarding geographic information activities. He said that legislation should be proposed with the purpose of enforcing greater coordination. In addition to investigating and moving forward in the areas described above, he said that FGDC should have more authority and accountability. A "carrot and stick" approach should be utilized to make agencies work more effectively together and with other levels of government. Strong leadership and direction is needed now to optimize geographic information efforts to achieve multiple benefits.

Sponsoring Agency Speakers

Skip Coghlan, Acting Director of Engineering, United States Forest Service

Skip Coghlan delivered a Forest Service (FS) perspective on Academy study issues. He began by talking about the FS mission: Caring for the Land and Serving People. This is to be accomplished by "sustained yield-multiple use" into perpetuity, managing natural resources. Geographic information and technology are tools for natural resource managers, not a product or end in themselves, and the use of GI tools efficiently through adding value, partnering, contracting, and using new technologies.

He provided some background on national forest natural resources. National forests cover 191 million acres, or 9 percent of the United States. Interspersed among these national forest lands are private lands, state lands, tribal lands, and other federal lands. There are 121 national forests, each with an average size equal to two average counties. Managing these huge tracts of land involves numerous complexities among resources and the demands on those resources. Most resource management responsibilities and activities require various kinds of geographical information, i.e., surveying and marking boundaries, mapping for public information, and resource mapping and inventory, remote sensing and GIS for resource analysis, alternatives, planning, and monitoring change.

However, none of these elements of resource management includes geographical information and technology as a specific mission or product. There are no FS budget line items for geographical information products.

Coghlan talked about using GI as a management tool for national forest resource managers. About 2 percent of the FS employees are geographical information specialists, or working full-time with geographical information. These employees possess expertise including land surveying, mapping, remote sensing , and Geographic Information Systems (GIS).

There are a few of these various specialists at the forest (i.e., field) level and in research. However, their staff assignments vary at different locations because GI is not a program per se. There are also several FS centers of expertise: the Geometronics Service Center, Remote Sensing Applications Center, and GIS Center of Excellence. These specialty areas provide the geographical information and technology support to the resource managers.

FS specialists undertake property surveys and update basic resource management map information. They digitize resource and map data for commercial printing of various map products. They prepare and administer surveying contracts, contracts for inventorying resources, and analysis of data. They also provide training and assistance to forest managers in selecting, using and trouble shooting different technologies.

Partnering has taken on many forms – sharing work and expertise, producing products, developing standards, exploring new technologies, and completing assessments. Through MOU's and agreements, FS has shared work and expertise with USGS, BLM, NASA, DOD, sister USDA agencies, etc. to create digital orthophotos and digital elevation models, produce maps, maintain the Geographic Coordinate Database, obtain aerial photography and satellite imagery, and assist with the location and elimination of illegal drug farms. The shared production of the "7.5 minute quads" in partnership with USGS and BLM especially demonstrated effective interagency coordination to eliminate duplication.

Participation on the Federal Geographic Data Committee and subcommittees, participation in the National Spatial Data Inventory committees, and participation in professional societies (e.g., the ASCM) provide opportunities to further eliminate duplication, and promote development of common data for ease of sharing and leveraging programs and resources. Partnerships in broad area ecosystem assessments, such as the Columbia River Basin and Southern Appalachian Assessments, have brought together states, counties, federal agencies, tribes, private landowners, and interest groups for boundary-less natural resource inventories and planning. The Great Lakes, Northern Great Plains and Ozark/Ouachita Highlands area assessments are further building on these successes.

Contracting includes everything from boundary surveys and monumenting, to digitizing and printing, to multi-spectral analysis and resource inventory. Downsizing of the federal government has further promoted the need to seek contracting opportunities.

He identified opportunities emerging as a result of technologies:

- Very high-resolution imagery — 1 meter ground sample distance or better, panchromatic and multi/hyperspectral — may soon be commercially available.
- Ability to browse and retrieve geospatial information on-line. Links within the agency, but outside to all our partners and users. Cost-effective, high-speed, high volume telecommunications will be critical to supporting the availability of data.
- Ability for customers to quickly plot/print at the user's site, Forest locations, or even rural stores and gas stations, high-quality map products of recreation information.
- Progress in bridging intelligence-community technologies into civilian applications, such as fire detection and fire suppression support.

New technologies will further bring the geographical information closer and more user-friendly to all customers, increasing the efficiency and effectiveness for resource management.

He summed up by saying there are three key messages about geographical information and the Forest Service.

- First, the Forest Service mission of Caring for the Land and Serving People. Managing all the Forest uses to sustain the resources for today and all tomorrows.
- Second, GI is a tool for accomplishing the FS mission. It is not our mission or product.
- Third, efficient provision of GI for forest management through adding value, partnering, contracting, and seeking new technology are central to current practices.

Kathy Clement, Senior Advisor for Data Production & Integration, United States Geological Survey

Kathy Clement said USGS' expectations were that the Academy report be credible, objective, comprehensive and based on facts and information, not ideology. She expressed the role of the sponsoring agencies as one to ensure that the Academy staff and panel had full access to data and information that would be useful and relevant to the scope of the study.

From a USGS point of view, the evolution of the National Mapping Program from primary producer of topographical maps and digital data to a fully integrated program has been a success. Its National Mapping Division's (NMD) goals have been focused on ensuring availability, utility, and access to base geospatial data for the nation. The NMD strategic plan directs the program for the next ten years.

She said the NMD program is unusual for a federal program in that it encompasses a fully integrated program including national policy, standards, user needs and requirements, data collection and integration, data applications and utility, data management, archive and access, customer satisfaction, and GPRA reporting requirements.

She highlighted four of the ten Academy study questions as fundamental to the success of NMD's mission:

- Public purpose: USGS views availability of public domain, basic geospatial information for the nation as a public good. Focus should be centered on the inherently governmental roles necessary to ensure GI as it serves public purpose.
- Outsourcing: NMD has been very aggressive and successful in partnering with the private sector.
- Partnerships: NMD's success is attributable to partnerships, including data collection. Partnerships are critical to sharing investments, sharing risks, and sharing benefits.
- Leadership and coordination: USGS supplies national leadership in data policy issues, development of national standards – standards as strategic alliance or framework for cooperation rather than data specifications – and coordination of "data-based" partnerships focused on outcomes (i.e., solving real problems through applications of geospatial data).

She talked about why the conference was important. The study process is sound, using Academy staff to perform information and data collection and analysis, and represents a unique opportunity for Academy Panel members to interact with policy representatives of the diverse geospatial data community on this critical issues.

The study report will be a product of the panel, not of the staff nor of the advisory board, so the outcomes may be viewed without bias. She encourage those present to communicate their views and perspectives on these issues directly to the "owners" of the study – the Academy panel.

Hord Tipton, Assistant Director of Minerals, Realty, and Resource Protection at the Bureau of Land Management (BLM)

Hord Tipton spoke about the history and evolution of BLM. Currently BLM lands cover 264 million acres surface (primarily in the western U.S.) and an additional 300 million acres of subsurface or mineral estate lands.

Jurisdiction and ownership on typical BLM area lands are checker board pattern. This contributes to complexity of management, these include National Park lands, Indian Reservation lands, State of Arizona lands, and private lands.

Tipton said BLM is a relatively young agency, 51 years old, but its roots predate the Constitution. BLM was formed in 1948 by combining U.S. Grazing Service and General Land Office. The Grazing Service was established in 1934 under the Taylor Grazing Act to address the western grazing problems. He described BLM as a conservation agency with minimal funding and the funding remains so today.

The General Land Office was created in 1812 as a result of the Land Ordinance Act of 1785. It was established for the orderly survey of the "Western" lands and inventory of timber, valuable minerals and agricultural potential. This established a mechanism for dispersion and disposal of federal lands for the common citizen. It is the bases of land ownership.

The General Land Office is the foundation of the Land Tenure system of the U.S. The act of 1785 provided the means for the transfer of millions of acres of federal land to private ownership. The General Land Office was the first inventory of our countries resources. This inventory is coarse by today's standard, it is a baseline of resource data for many areas of the country and is the baseline of legal land ownership. The General Land Office was among the first federal agencies to see the value in collecting and maintaining geographic information.

He talked about BLM's current activities, all of which rely on GI. He stressed that land survey and land ownership are key to managing these activities.

Partnerships/Sharing are central to BLM activities. He cited several examples currently in use:

- Trading Posts
- Collocation/Consolidation
- Centers of Excellence
- State/County/Local Governments
- National Partnerships - Government/Private
- FGDC - Geographic Coordinate Data Base (GCDB)

He expounded on the GCDB noting that BLM is the lead agency for cadastral data under the Federal Geographic Data Committee. In house expertise, heritage from the General Land Office, and the development of the Geographic Coordinate Data Base all contribute to BLM'S leading role in the public land tenure system.

Tipton said BLM uses the interagency concept of the FGDC for multi agency participation in developing standards for the National Spatial Data Infrastructure (NSDI). He noted that BLM has expended considerable funds and resources in collection of the GCDB and in preparation of the evolving standards.

Tipton talked about current responsibilities of BLM that contribute to their inherently governmental functions. BLM has the responsibilities to manage a large land area and to serve as the steward of these lands. Additionally, BLM seeks to operate as a business, tempered by legislative functions and congressional oversight.

He attempted to describe the functions in BLM that are inherently governmental. He said this question solicits numerous responses, depending on who provides the opinion.

He cited as inherently governmental:

- Land Tenure - The maintenance of the Public Land Survey System as the foundation for land ownership. This is critical to the federal government and the nation as a whole.

- Good decisionmaking is critical for land management and can only be executed with the best geographic information.
- Core management functions with the needed skills and expertise to properly analyze geographic information are inherent to BLM's mission.
- Outsourcing services, support and production are good business practices: i.e. data collection, software support and limited assemblage of geographic information products.

He concluded with BLM's expectations of the Academy study. He said there were basically three overlapping issues:

- Efficient Business Practices
    - Appropriate levels of expertise needed in geographic information
    - Identify quality and efficiency in technological trends
    - Recommended improvement in partnerships, cooperative and data sharing.
- Support for the Land Tenure System
    - BLM's relationship to the federal survey systems and land ownership and BLM's lead role in the development and maintenance of the Land Tenure System.
- Support of land and resource management
    - Recommendation and affirmation of geographic information's role for sound land and resource management policies.

Glen Boledovich, Policy Analyst, National Ocean Service

Glen Boledovich's said that although the scope of the Academy project is broad, the four participating agencies only represent a narrow sampling of the Federal investment in civilian geospatial data. Agencies not participating directly include NASA, EPA, FEMA, and the Army Corps of Engineers – and they all have extensive geospatial data programs to meet their specific responsibilities.

He said that the broad scope of the study leads NOS to believe that the study should provide equally broad recommendations that will provide a solid policy base for coordinating the burgeoning applications of Federal geospatial data as we head into the next century. The need to be able to readily exchange and share data is paramount. To that end, he feels the panel's list of primary questions are for the most part on target.

The primary questions for the panel include:

- Functions that are critical to U.S. competitiveness in the global economy
- Federal role in contrast to state and private roles
- Coordination of federal geospatial efforts to reduce duplication of effort.

He stated that NOS believes the panel could, and probably should, conclude that federal geographic information functions can be more effective, and might help determine which programs are critical to keeping the U.S. competitive in the global economy. Emphasis should not be placed on reaching specific, narrow conclusions regarding restructuring and shifting of programs, and be "valid, credible and authoritative." He found that recommendations in previous studies that have focused on such details have, for a variety of reasons, gone unheeded. Furthermore, in today's technological climate of enhanced communication and data sharing, such recommendations are arguably increasingly less relevant to achieving efficient sharing of geospatial data.

Boledovich stated the priorities faced by GI planning: the need to balance the budget, the administration's goal to reinvent delivery of federal services, and private sector pressures on the Congress and the Administration to outsource functions traditionally performed in-house. All contribute to the debate over the role of the federal government in geographic information coordination.

He said the result is that downsizing, privatization, commercialization, and outsourcing have become increasingly popular buzzwords in Washington. NOS is concerned that these pressures will be used as an excuse to weaken long-standing Federal commitments and responsibilities.

He gave an example that the nautical charting and geodesy programs at NOS have been located together and deemed Federal responsibilities since 1807. While the private sector has expressed an interest in contracting for some aspects of these functions, there has been no interest expressed in full privatization – i.e. the private sector expects the Federal government to continue to fund and maintain responsibility for the overall programs. He stated that any shift of these responsibilities to states would have to consider the creation of unfunded mandates.

He pointed out that at a recent hearing on the Freedom from Government Competition bill, which is pending in Congress, the Government Accounting Office promoted the use of Competitive Contracting:

- where the government and private sector compete to provide certain services
- help make an initial determination of whether it is a private sector source or an agency that provides certain goods or services for the best value

NOAA promoted the same idea for its hydrographic surveying functions in testimony to the Congress in April.

He stated GAO noted that effective monitoring and oversight of contractor performance are essential, that implementing contracting carries its own responsibilities, and agencies converting to contracting will need to develop considerable contract management capability. NOAA has argued the same position in justifying the need to maintain Federal expertise to quality control contractor data. At the same hearing this was underscored also in American Society of Civil Engineers (ASCE) testimony.

Other studies of NOAA's charting function reached similar conclusions, and NOAA has long insisted that its charting program mission to promote safe navigation fulfills multiple governmental responsibilities including protecting life and property, stewardship of coastal marine resources, and facilitation of international trade. Also, NOAA has consistently promoted a responsible transition to increased outsourcing.

Boledovich mentioned that NOS offers three models for working with states, local authorities, and the private sector – the Geodetic Advisor program, the CZMA, and the long-standing practice of the nautical charting program for local input and coordination.

- **Geodetic Advisor program** is voluntary and has the participation of half the states. Generally, states and the federal government split the costs, although some states have shifted to fully funding the position, but requested continued treatment as advisors.
    - Advisors work in and for the state where located.
    - The program provides an excellent avenue to transfer new technologies and applications of basic geodetic positioning data and techniques.
    - In some states it has provided a conduit for cooperative efforts on other technical geospatial issues, such as nautical charting and tides and water levels.
    - It is not difficult to foresee some benefits of having a similar program of state or regional Federal Geographic Data Advisors that have expertise and knowledge of all Federal geospatial data applications for a given area.
- The CZMA by design is a Federal/state partnership aimed at achieving sustainable development of coastal economies and environments. It provides a network of state managers through which Federal scientific and technical expertise can be directed.
- The NOS Coastal Services Center is specifically designed to be the conduit for delivering highly technical, and most often geospatial, data from all Federal sources to state and local authorities in coastal states.
- The center's mission is in part to bridge the gap and promote applications of geospatial data by state coastal resource managers.

Glen Boledovich concluded by stating that NOAA's Coast Survey, Geodetic Survey, and Coastal Services Center are all active members of the Federal Geographic Data Committee. He views the strengthening of the FGDC as an important, if not fundamental step, in improving the coordination of federal geospatial data management.

State and Local Governments and the Private Sector Speakers

Jonathan Howes, Secretary Department of Environment, Health and Natural Resources, North Carolina

Jonathan Howes, began his remarks, entitled "The Future: Promise and Problems", by talking about the role of states the NSDI. He noted the tremendous importance state geographic information activities are to a "national" NSDI. States, as users and producers of data, are in the "middle of the food chain", that is, between federal and local government geographic data activities. In this position, states can serve to organize geographic data activities in a number of ways. States serve a important role in guiding data development and facilitating the creation and activation of coordination groups.

Howes proceeded to give a state perspective on several Academy study issues. He began by addressing the questions of appropriate mechanisms for integrating GI activities across governments. On the issue of policy bases Howes said that if legislation were proposed, it should have as a goal the creation of a national spatial data program. This would require strengthening the FGDC. He also said the policy base should be reorganized to put greater effort and attention into the activities of "framework data" producers.

Howes said the creation of a National Spatial Data Committee could provide the necessary structure and organization that is currently lacking in FGDC activities. A national committee would be more inclusive of all levels producers and users of GI. A national committee would be more likely to sustain a national debate on the current and future direction of GI, leading to greater coordination and cooperation among interested parties.

A national committee could also serve as the central US voice for international GI efforts. The committee would have to be broad based, calling on multiple sectors of the GI community for input. Howes suggested the EUROGI model for consideration in a US national committee.

Howes then talked about the critical role of partnerships to strengthen current GI activities. He stressed the potential contribution of federal field operations. Agency coordination with states can be achieved on broad issues. The NFNC was sited as an example. Also, interagency coordination on spatial data (e.g. NCFIC) can provide tremendous benefits to all those who participate. Howes also cited widespread participation in state geographic information councils as central to improving the relation of all GI producers and users.

Howes then turned to the issue of GI as it serves the public purpose. The first step, he said, is to ask what activities have a public purpose. After the functions that include public purpose activities are identified, the next question that should be asked is which, if any, of these activities is it appropriate to outsource? What activities, if any, can be fully commercialized without compromising the fundamental nature of the public purpose that is served by that activity. Howes summed up his perspective by saying one size does not fit all. Each activity should be evaluated independently based on the environment that particular GI function operates in.

Howes said several functions fit neatly under the public purpose umbrella. Specifically, governments should be directly involved in setting standards, ensuring accuracy, uniformity, and completeness, and producing and/or distributing some data (transactions of business operations, security requirements, sunken costs in equipment and expertise)

He suggested some guidelines on when to outsource data production and/or distribution. As a general rule, outsourcing should be pursued if it's practical, cost effective, and if the program manager believes it's appropriate.

If the function should be outsourced, it may also be appropriate to fully commercialize the activity.

Dave Edwards, Vice President of Space Imaging EOSAT.

Dave Edwards, Vice President of EOSAT Corporation was asked to present a snapshot of private sector activities related to GI. He began by talking about global commercial satellite imagery objectives.

Edwards then gave an industry view of trends in user imagery. He said the current trend is toward high information content products. A variety of aerial imagery tools generate data. Value is added to the data, creating information products.

Edwards described the market of GI consumers the following way:

- *1998 Addressable Market*
    - **$600M North America**
    - **$300M DoD/Intelligence**
    - **$900M International**

He described a hierarchy of GI activities beginning with radiometric correction, then geometric correction using satellite metadata, then geometric correction using ground control points, then digital elevation models of terrain and structures, and orthorectification. At the top of the pyramid is the achievable objective of the seamless mosaic.

He described geospatial information needs and imagery and information trends, including the availability of aerial photography (Figure G-1). He said information fusion of geospatially referenced information is being called for by customers. Many types of collateral data, such as agricultural, street, and civil data are collected by a variety of public and private sources, using a variety of imagery tools. Private sector providers are working toward full integration of these disparate data sets.

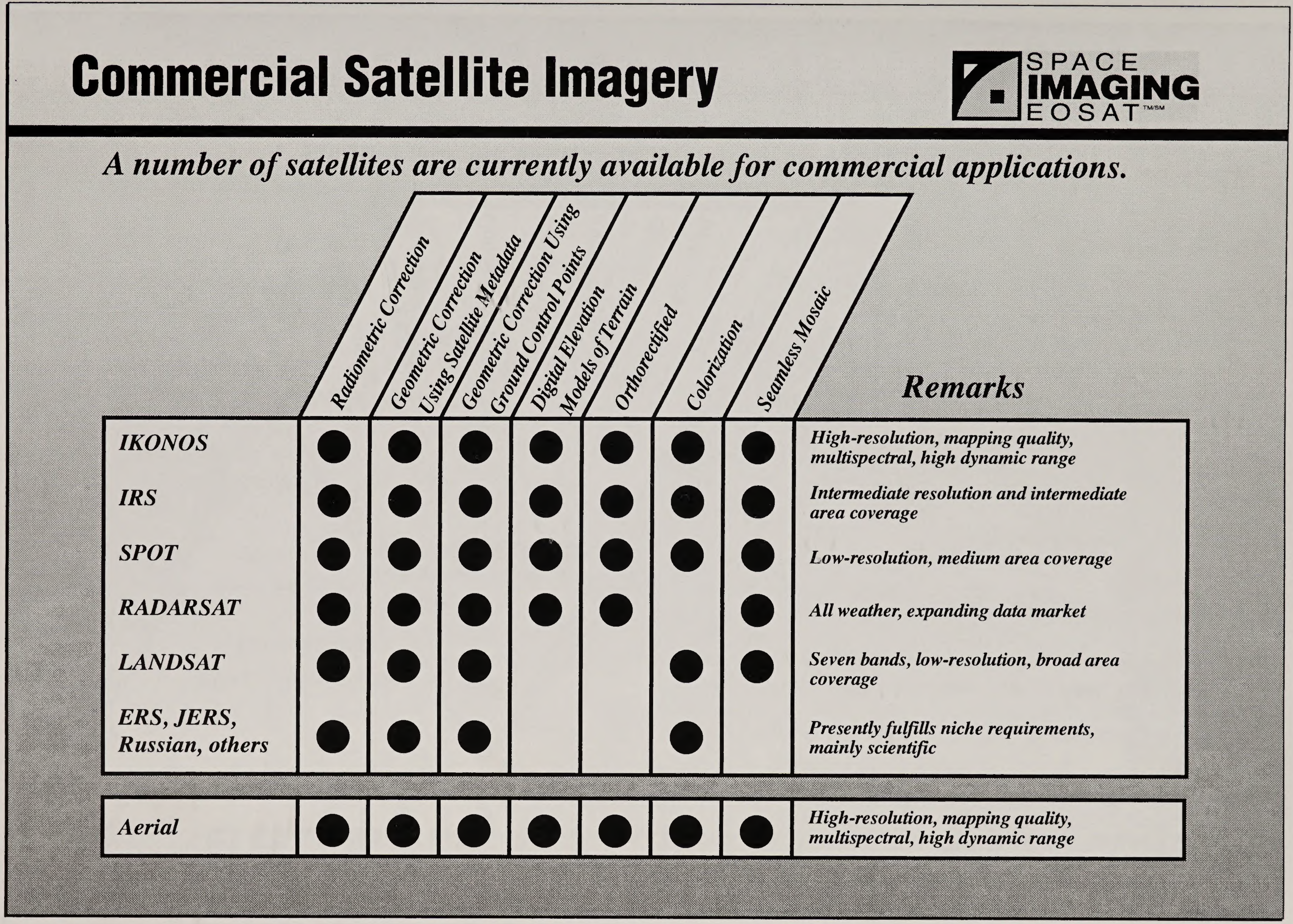
Edwards described the basis for the demands for imagery products. Of the estimated total 1998 market of $4.2 Billion, the following sources are estimated to account for the demand (in millions):

State and federal government - $86M; Local government - $576M; Utilities $464M; Resource exploration $24M; Telecommunication $96M; Construction $232M; Logistics $96M; Media $32M; Insurance $34M; Other $366M

Regarding commercial satellite imagery Edwards read a quote "The North American market for GIS products and services... had a yearly growth of 15–27 percent between 1988–91 with total sales under $1B in 1991. This year's U.S. budget for GIS is $4.5B and world wide software sales are continuing to increase by about 20 percent per year...Federal Agencies alone are spending $2.5–3.0B annually on collection and management of geospatial data." "**GIS Task Force Report**" (Figure G-2)

Edwards described the future demands likely to be placed on the imagery market. Information needs will drive data service markets (Figure G-3).

FIGURE G-1: COMMERCIAL SATELLITE IMAGERY



Commercial Satellite Imagery

SPACE IMAGING EOSAT™/SM

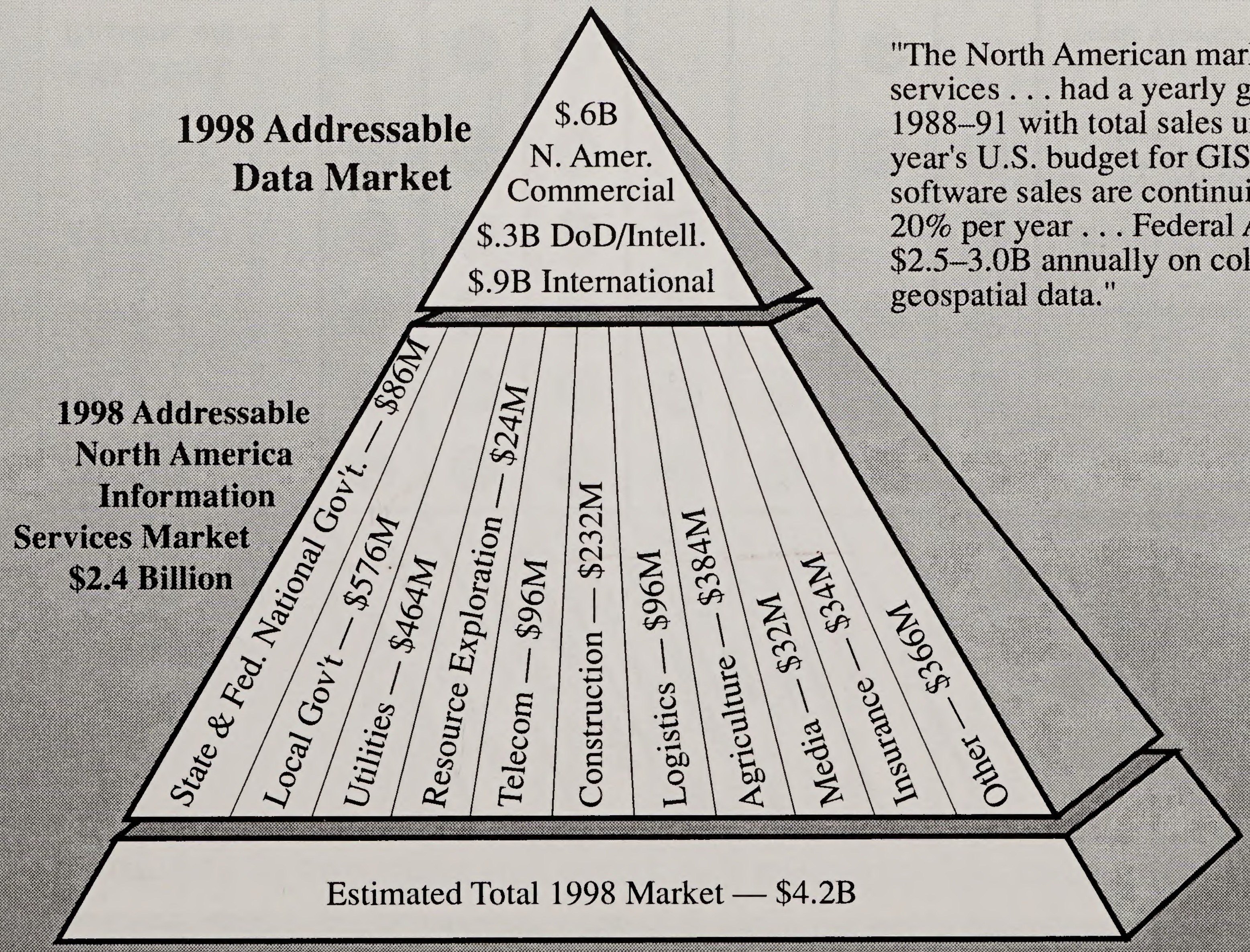
A number of satellites are currently available for commercial applications.

	Radiometric Correction	Geometric Correction Using Satellite Metadata	Geometric Correction Using Ground Control Points	Digital Elevation Models of Terrain	Orthorectified	Colorization	Seamless Mosaic	Remarks
IKONOS	●	●	●	●	●	●	●	*High-resolution, mapping quality, multispectral, high dynamic range*
IRS	●	●	●	●	●	●	●	*Intermediate resolution and intermediate area coverage*
SPOT	●	●	●	●	●	●	●	*Low-resolution, medium area coverage*
RADARSAT	●	●	●	●	●		●	*All weather, expanding data market*
LANDSAT	●	●	●			●	●	*Seven bands, low-resolution, broad area coverage*
ERS, JERS, Russian, others	●	●	●			●		*Presently fulfills niche requirements, mainly scientific*
Aerial	●	●	●	●	●	●	●	*High-resolution, mapping quality, multispectral, high dynamic range*

FIGURE G-2: COMMERCIAL MARKET PUSH AND PULL

Commercial Market Push and Pull

SPACE IMAGING EOSAT™/SM



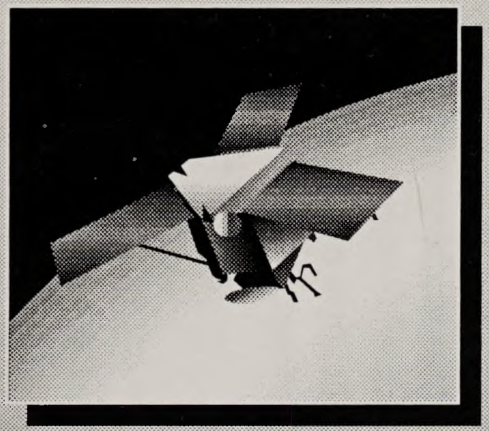
"The North American market for GIS products and services . . . had a yearly growth of 15–27% between 1988–91 with total sales under $1B in 1991. This year's U.S. budget for GIS is $4.2B and world wide software sales are continuing to increase by about 20% per year . . . Federal Agencies alone are spending $2.5–3.0B annually on collection and management of geospatial data."

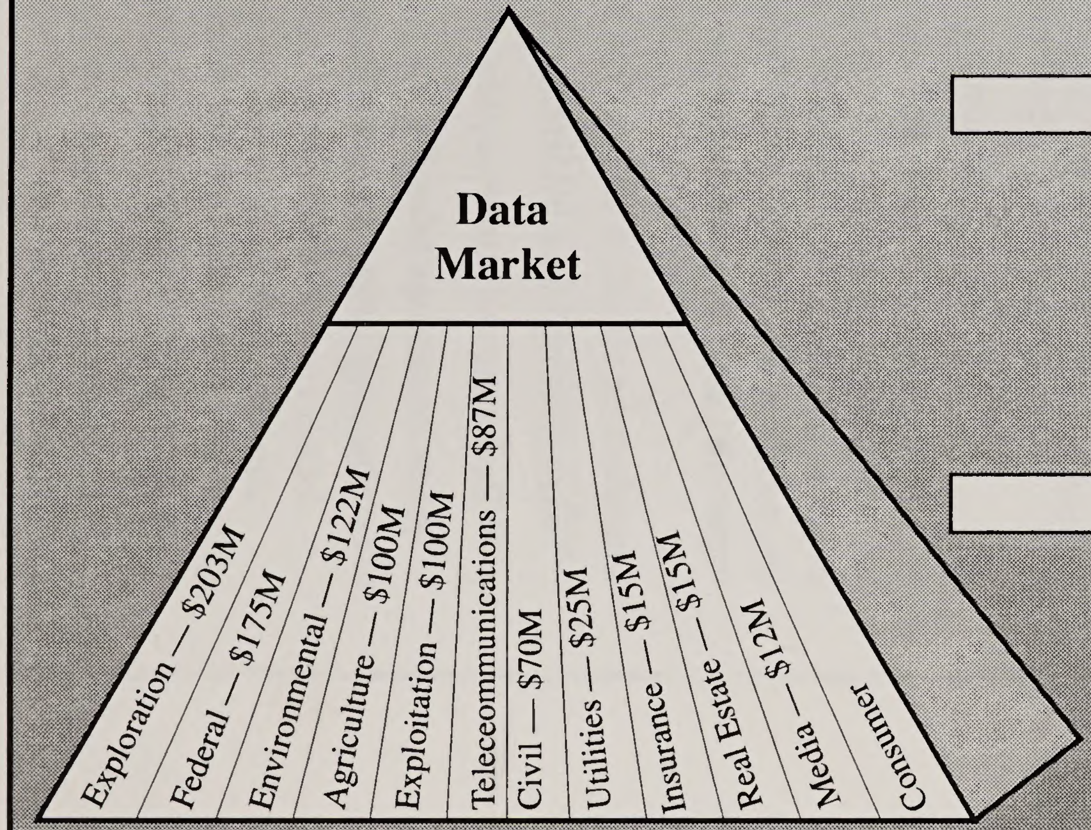
"GIS Task Force Report"

FIGURE G-3: INFORMATION AND DATA SERVICE MARKETS

Information and Data Service Markets

SPACE IMAGING EOSAT™/SM





Smaller
Higher Resolution
More Bands (Hyperspectral)
More Sensors

Automated Processing
Change Detection
2.5-D Automated
3-D Automated
Fusion
Micro Relief and Models

Distribution
Timelines
Ease of Use
Third Party Proliferation

Information Needs

Terry Wood, Councilman at Large, City of Jacksonville, FL

Terry Wood gave the perspective of both the City of Jacksonville and Duval County, Fl. He is on the Board of Directors of the National Association of Counties and Chair of its Information Technology Committee. He stated that counties are political subdivisions of states and frequently find themselves charged with carrying out state missions.

He gave a summary of NACo's activities.

- Lobby for county government nationally to Congress, the federal government and other national/international efforts
- Provide services to counties where those services are best provided at the national (rather than state or local) level, and
- Encourage communication, coordination and the development of best practices in and between counties.

NACo's perspective on the value of geospatial data is:

- Local governments are the basic service provider to the citizen.
- With devolution, the services provided by local government will expand.
- Almost every function of local government has, or should have, a geospatial component for maximum effectiveness at both the operational and management level (tactical and strategic):
  - Emergency vehicle dispatch
  - Property recording and assessment
  - Maintenance (e.g., pothole repair) of county roads
  - Public transportation routing (mass transit systems)
  - Watershed infrastructure
  - Zoning and land use planning
  - Location of social service nodes
  - Utility line location (use, permits and easement control)

Therefore he stated, with sensible application of geospatial data, counties will be

- Integrating more information
- Reducing redundant operations
- Saving taxpayer dollars and
- Allowing public coalitions (such as neighborhood associations) to use data to better explain their problems (regarding such areas as environmental justice, zoning issues or new roadways).

He stated the role of NACo and Counties in NSDI:

- Local governments are the traditional maker, keeper and preserver of land-related information
- Local government therefore plays a key role in geospatial data collection for all levels of government

- To perform this pivotal role, local governments need geospatial data at a detail level of greater resolution than required by most agencies
- Counties need this data resolution to provide basic services required by law or function
- Counties have the most stringent geospatial requirements and the fewest dollar resources

Therefore, for commonality of use (least common denominator), framework data should be refocused to the county (local) level.

- Since counties do not live in a vacuum (rivers do not start and end in Duval County), practical standards (or translation mechanisms) are important.
- NACo would like to see incentives provided to have counties produce geospatial data required for operation and management decisionmaking – but in a form others can use.

He gave a list of what it will take to build a national data infrastructure, identifying the realities that will be operating throughout the process.

First, the structure must be founded on the data which is the lowest common denominator and requiring the greatest detail – that is, the local or county level. From this level, everything else can be layered.

- The county maintains the land record.
- Cities, counties and citizens need detailed land records
- 1/100,000 or 1/24,000 level of detail won't work for most of the activities occurring at the local level

Second, legislative mandates will not work. Cooperative partnerships provide the best opportunity for the future. A legislative authorization enabling this process to continue may or may not be helpful. If so, local government officials might be able to assist in working with Congress. In the final analysis, however, different levels of government need to refocus their thinking to one featuring partnerships between levels of government and across all sectors of the national community.

Third, vendors and the OGC need encouragement to speed up development of interoperability efforts currently underway.

Fourth, resources already exist within the various levels of government and range of agencies that can be refocused to provide the resources necessary to build the seamless data structure we envision for the future.

Finally, all levels of government need to recognize that geospatial information rapidly is becoming a critical element of decisionmaking as well as operations and, as such, becomes the property of all.

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APPENDIX H

Selected Bibliography

FEDERAL

Congressional

Congressional Budget Office. *The Growth of Federal User Charges: An Update.* Washington, DC: Congressional Budget Office, 1995.

Senate Committee on Governmental Affairs. *Hearing Before the Senate Committee on Governmental Affairs: Improving Management and Organization in Federal Natural Resources and Environmental Functions,* June 27, 1996.

Permanent Select Committee on Intelligence. *IC21: Intelligence Community in the 21st Century: Staff Study, Permanent Select Committee on Intelligence,* House of Representatives, 104th Congress. Washington, D.C.: U.S. Government Printing Office, 1996.

Senate Committee on Governmental Affairs. *Hearing Before the Senate Committee on Governmental Affairs on S. 1724, Freedom from Government Competition Act of 1996 Prepared Comments of Witnesses.* Washington, D.C.: United States Senate, 1996.

General Accounting Office

General Accounting Office. *Federal Grants: Design Improvements Could Help Federal Resources Go Further: Report to the Chairman, Committee on the Budget, House of Representatives.* Washington, D.C.: General Accounting Office, 1996.

________. *Federal Land Management: Streamlining and Reorganization Issues: Statement of Michael Gryszkowiec, Director of Planning and Reporting, Resources, Community, and Economic Development Division, before the Committee on Governmental Affairs, United States Senate.* Washington, D.C.: General Accounting Office, 1996.

________. *Forest Service Is Making Progress in Developing a Nationwide Geographic Information System: Statement of JayEtta Z. Hecker, Director, Resources, Community, and Economic Development Information Systems, Information Management and Technology Division, before the Subcommittee on Interior and Related Agencies, Committee on Appropriations, House of Representatives.* Washington, D.C.: General Accounting Office, 1991.

________. *Forest Service: Status of Geographic Information System Acquisition, Report to the Chairman, Subcommittee on Interior, Committee on Appropriations, House of Representatives.* Washington, D.C.: General Accounting Office, 1989.

________. *Geographic Information System: Forest Service Has Resolved GAO Concerns About Its Proposed Nationwide System: Statement of JayEtta Z. Hecker, Director, Resources, Community, and Economic Development Information Systems, Information Management and Technology Division, before the Subcommittee on Interior and Related Agencies Committee on Appropriations, House of Representatives.* Washington, D.C.: General Accounting Office, 1992.

________. *Geographic Information System: Forest Service Not Ready to Acquire Nationwide System, Report to the Chairman, Subcommittee on Interior and Related Agencies, Committee on Appropriations, House of Representatives.* Washington, D.C.: General Accounting Office, 1990.

________. *Geographic Information System: Information on Federal Use and Coordination: Fact Sheet for the Chairman, Committee on Government Operations, House of Representatives.* Washington, D.C.: General Accounting Office, 1991.

________. *Geographic Information System: Status at Selected Agencies: Fact Sheet for the Chairman, Subcommittee on Interior and Related Agencies, Committee on Appropriations, House of Representatives.* Washington, D.C.: General Accounting Office, 1990.

________. *Government Reorganization: Observations on the Department of Commerce: Statement of L. Nye Stevens, Director, Federal Management and Workforce Issues, General Government Division, before the Committee on Governmental Affairs, United States Senate.* Washington, D.C.: General Accounting Office, 1995.

________. *Land Management Systems: Extensive Cost Increases and Delays in BLM's Major Data Base Project: Report to the Chairman, Subcommittee on Government Operations, House of Representatives.* Washington, D.C.: General Accounting Office, 1991.

________. *Land Management Systems: Information on BLM's Automated Land and Mineral Record System Release 2 Project.* Washington, D.C.: General Accounting Office, 1997.

________. *Land Management Systems: Progress and Risks in Developing BLM's Land and Mineral Record System: Report to the Chairman and Ranking Minority Member, Subcommittee on Interior and Related Agencies, Committee on Appropriations, House of Representatives.* Washington, D.C.: General Accounting Office, 1995.

________. *Land Management Agencies: Major Activities at Selected Units Are Not Common Across Agencies: Report to Congressional Requesters.* Washington, D.C.: General Accounting Office, 1997.

________. *National Airspace System: Comprehensive FAA Plan for Global System Is Needed, Report to the Committee on Transportation and Infrastructure, House of Representatives.* Washington, D.C.: General Accounting Office, 1995.

________. *Ocean Research Vessels: NOAA Fleet Modernization Plan, Statement of John Anderson, Jr., Associate Director, Resources, Community and Economic Development Division, before the Subcommittee on Oceanography, Gulf of Mexico and the Outer Continental Shelf, Committee on Merchant Marine and Fisheries, House of Representatives.* Washington, D.C.: General Accounting Office, 1993.

________. Privatization and Competition: Comments on S. 314, the Freedom from Government Competition Act. Washington, DC, General Accounting Office, June, 1997

________. *Research Fleet Modernization: NOAA Needs to Consider Alternatives to the Acquisition of New Vessels, Report to Congressional Committees.* Washington, D.C.: General Accounting Office, 1994.

Executive Branch

Clinton, William. "Executive Order 12906: Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure." *Federal Register* 59 (April 1994): 17671–17674.

Committee on Environment and Natural Resources Research

Subcommittee on Global Change Research. *The U.S. Global Change Data and Information System Implementation Plan.* Washington, D.C.: Global Change Information Research Office, 1994.

Federal Emergency Management Agency

Federal Emergency Management Agency. *Technology Applications by the Federal Emergency Management Agency in Response, Recovery and Mitigation Operations Following Natural Disasters.* Washington, D.C.: Federal Emergency Management Agency, prepared for the 27th Joint Meeting of the U.S./Japanese Panel on Wind and Seismic Effects, 1995.

Federal Emergency Management Agency-GIS Mapping and Analysis Center. *Production Catalog.* Washington, D.C.: Federal Emergency Management Agency, 1996.

Federal Geographic Data Committee

Federal Geographic Data Committee. *Building the National Spatial Data Infrastructure: A Progress Report 1993–1995.* Washington, D.C.: Federal Geographic Data Committee, 1996.

________. *Charter for the Federal Geodetic Control Subcommittee.* Washington, D.C.: Federal Geographic Data Committee, 1995.

________. *Charter for the Historical Data Working Group.* Washington, D.C.: Federal Geographic Data Committee, 1996.

________. *Content Standards for the Digital Geospatial Metadata Workbook.* Washington, D.C.: Federal Geographic Data Committee, 1995.

________. *Development of a National Geospatial Data Framework.* Washington, D.C.: Federal Geographic Data Committee, 1995.

________. *Earth Cover Working Group Charter.* Washington, D.C.: Federal Geographic Data Committee, 1996.

________. *Manual of Federal Geographic Data Products.* Washington, D.C.: ViGYAN, Inc., 1992.

________. *The 1994 Plan for the National Spatial Data Infrastructure: Building the Foundation of an Information Based Society.* Washington, D.C.: Federal Geographic Data Committee, 1994.

________. *A Strategy for the National Spatial Data Infrastructure.* Washington, D.C.: Federal Geographic Data Committee, 1997.

National Aeronautics and Space Administration

National Aeronautics and Space Administration. *Committee on Science, House of Representatives, Statement by Dr. Charles F. Kennel, Associate Administrator, Mission to Planet Earth.* Washington, D.C.: NASA, 1996.

________. *Mission to Planet Earth Education Strategy.* Washington, D.C.: NASA, 1996.

________. *NASA's Mission to Planet Earth: Earth Observing System.* Washington, D.C.: NASA, 1993.

________. *Mission to Planet Earth: Science Research Plan.* Washington, D.C.: NASA, 1996.

________. *Understanding Our Changing Planet: NASA's Mission to Planet Earth Fact Book.* Washington, D.C.: NASA, 1995.

________. *Understanding Our Changing Planet: NASA's Mission to Planet Earth 1996 Fact Book.* Washington, D.C.: NASA, 1996.

Office of Management and Budget

Office of Management and Budget. *Report of the Federal Mapping Task Force on Mapping, Charting, Geodesy and Surveying.* Washington, D.C.: U.S. Government Printing Office, 1973.

________. *Circular A-11: Preparation and Submission of Budget Estimates.* Washington, D.C.: Office of Management and Budget, 1995.

________. *Circular A-16: Coordination of Surveying, Mapping, and Related Spatial Data Activities. Revised* Washington, D.C.: Office of Management and Budget, October 19, 1990

U.S. Department of Agriculture

Forest Service

Alaska Region Engineering and Aviation Management. *Five Year Cadastral Survey Program (draft).* Alaska: Forest Landline Surveyors (assembled by Ron Skillings), 1997.

Forest Service. *Analysis in Support of Ecosystem Management, compiled by Joyce Elma Thompson for Analysis Workshop III.* Washington, D.C.: U.S. Department of Agriculture, 1995.

________. *Cadastral Survey Contracting: Seven Issues for the USDA Forest Service.* Washington, D.C.: U.S. Department of Agriculture, 1988.

________. *Corner Search, Perpetuation and Recordation: A Training Guide.* Washington, D.C.: U.S. Department of Agriculture, 1986.

________. *Engineering and Related Skills in Ecosystem Management.* Washington, D.C.: U.S. Department of Agriculture, 1995.

________. *The Forest Service Program for Forest and Rangeland Resources: A Long-Term Strategic Plan (draft 1995 RPA Program).* Washington, D.C.: U.S. Department of Agriculture, 1995.

________. *Geographic Information System Evaluation Report.* Washington, D.C.: U.S. Department of Agriculture, 1992.

________. *Geometronics Service Center.* Salt Lake City, UT: U.S. Department of Agriculture, 1996.

________. *Guidelines for the Use of Digital Imagery for Vegetation Mapping.* Washington, D.C., U.S. Department of Agriculture, 1995.

________. *Information Management: A Framework for the Future.* Washington, D.C.: U.S. Department of Agriculture, 1992.

________. *Land Management Considerations in Fire-Adapted Ecosystems: Conceptual Guidelines.* Washington, D.C.: U.S. Department of Agriculture, 1996.

________. *Land Mines: A Productivity Analysis.* Washington, D.C.: U.S. Department of Agriculture, undated.

________. *Land Surveying: Chapter 7150.* Washington, D.C.: U.S. Department of Agriculture, 1990.

________. *Land Surveying Guide.* Washington, D.C.: U.S. Department of Agriculture, 1983.

________. *The Principal Laws Relating to Forest Service Activities.* Washington, D.C.: Forest Service Legislative Affairs Office, 1993.

________. *RPA Assessment of the Forest and Rangeland Situation in the United States.* Washington, D.C.: U.S. Department of Agriculture, 1993.

________. *Remote Sensing Applications Center: Remote Sensing Applications for the Present and the Future.* Washington, D.C.: U.S. Department of Agriculture, 1996.

________. *Summary of USDA Forest Service Geospatial Activities.* Salt Lake City, UT: Geometronics Service Center, 1996.

________. *Summary Report: The Southern Appalachian Assessment.* Oak Ridge, TN: Oak Ridge National Laboratory, July, 1996.

National Resources Conservation Service

A Framework Plan Linking GIS Technology with FOCS and NRCS Business Activities: Geospatial Natural Resources Data and Geospatial Processing, September 1995.

National Resources Conservation Service. *Data Rich and Information Poor: A Report to the Chief of the Natural Resources Conservation Service by the Blue Ribbon Panel on Natural Resource Inventory and Performance Measurement.* Washington, D.C.: U.S. Department of Agriculture, 1995.

________. *National Resources Conservation Service Fiscal Year 1997 Budget.* Washington, D.C.: U.S. Department of Agriculture, 1996.

________. *1992 National Resources Conservation Service Inventory Environmental and Resource Assessment Symposium.* Washington, D.C.: U.S. Department of Agriculture, 1994.

________. *National Resources Conservation Service Strategic Plan for Fiscal Years 1996–2002 (draft).* Washington, D.C.: U.S. Department of Agriculture, 1997.

________. SSURGO: *Foundation for a Geospatial Agency: Soil Survey Digitizing Quality Improvement Team Report.* Washington, D.C.: U.S. Department of Agriculture, 1996.

________. Summary Report: *1992 National Resources Inventory.* Washington, D.C.: U.S. Department of Agriculture, 1992.

U.S. Departments of the Army and the Air Force

National Guard Bureau. *Annual Review of the Chief, Fiscal Year 1994.* Washington, D.C.: National Guard Bureau, 1994.

U.S. Department of Commerce

U.S. Departments of Commerce and Transportation, Offices of the Inspector General. *NOAA's Office of Aeronautical Charting and Cartography Should Transfer to FAA.* Washington, D.C.: U.S. Departments of Commerce and Transportation, 1996.

Bureau of the Census

Franz, Linda and Joel Sobel. *Geographic Support for the Programs of the Bureau of the Census.* Washington, D.C.: U.S. Department of Commerce, undated.

Lamacchia, Robert. *The TIGER File and Redistricting, delivered at Reapportionment and the 1990 Census.* Washington, D.C.: U.S. Department of Commerce, 1989.

________. *The TIGER System, prepared for the 1990 Exemplary Systems in Government Awards Competition.* Washington, D.C.: U.S. Department of Commerce, 1990.

Marx, Robert. *Computer Mapping and the Census Bureau: The Future and You, presented by Robert W. Marx to the AM/FM International Eastern Regional Conference.* Washington, D.C.: U.S. Department of Commerce, 1986.

—. "The TIGER System: Automating the Geographic Structure of the United States Census." *Government Publications Review* 13 (1986): 181–201.

Sobel, Joel. *Principal Components of the Census Bureau's TIGER File, presented by Joel Sobel at the Ninth Annual Applied Geography Conference.* Washington, D.C.: U.S. Department of Commerce, 1986.

NOAA/NOS Geodetic Survey

Brown, Patricia and David Moyer, eds. *Multipurpose Land Information Systems: The Guidebook, Volumes I and II, prepared by The Federal Geodetic Control Committee.* Washington, D.C.: U.S. Department of Commerce, 1989.

Coast and Geodetic Survey. *Second Report to Congress on the Impact of Increased Aeronautical and Nautical Chart Prices Resulting from Public Law 99-272 on Public Sales and Navigation Safety.* Rockville, MD: Coast and Geodetic Survey, 1992.

Coastal Stewardship Task Force, *Recommendations for Improving the Coastal Stewardship Mission of the National Oceanic and Atmospheric Administration,* US Department of Commerce, July, 1996.

Federal Geodetic Control Committee. *Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques.* Rockville, MD: Federal Geodetic Control Committee, 1989.

________. *Standards and Specifications for Geodetic Control Networks.* Rockville, MD: Federal Geodetic Control Committee, 1984, 1993.

Federal Geodetic Control Subcommittee. *Standards for Geodetic Control Networks (draft).* Silver Spring, MD: Federal Geodetic Control Subcommittee, 1995.

Market Facts, Inc. *An Estimation of Demand for Nautical Chart Products, presented to National Oceanic and Atmospheric Administration.* Arlington, VA: Market Facts, Inc., 1984.

National Geodetic Survey. *August 1994 Forum on Implementing NAVD88 for California: Final Report, coordinated by Don D'Onofrio.* California: National Geodetic Survey, 1994.

________. *National Geodetic Survey: Catalog of Products and Services.* Silver Spring, MD: U.S. Department of Commerce, 1995.

________. *National Geodetic Survey: Its Mission, Vision, and Strategic Goals.* Silver Spring, MD: U.S. Department of Commerce, 1994.

________. *Organization Handbook, Promote Safe Navigation, 5-year Implementation Plan,* April, 1997.

National Oceanic and Atmospheric Administration. *Annual Report: Coast and Geodetic Survey.* Silver Spring, MD: National Oceanic and Atmospheric Administration and National Ocean Service, 1994.

________. *Dates of Latest Editions: Nautical Charts and Miscellaneous Maps.* Washington, D.C.: U.S. Department of Commerce, 1996.

________. *Mechanisms for Privatization of NOAA Functions.* Washington, D.C.: NOAA General Counsel, 1995.

________. *NOAA 1994 Confidential Survey: Boaters, prepared by Strategy, Research and Action, Ltd.* London: Strategy, Research and Action, Ltd., 1994.

________. *The Nautical Charting Plan.* Washington, D.C.: U.S. Department of Commerce, 1995.

________. *Office of NOAA Corps Operations Fiscal Year 1996 Operating Plan.* Washington, D.C.: U.S. Department of Commerce, 1995.

________. *Safe Passage into the 21st Century: Modernizing NOAA's Navigational Services.* Washington, D.C.: U.S. Department of Commerce, 1995.

________. *Safeguarding Our Nation's Waterways with PORTS: A Report to the House of Representatives, Committee on Appropriations.* Washington, D.C.: U.S. Department of Commerce, 1994.

________. *Strategic Plan: A Vision for 2005, Executive Summary.* Washington, D.C.: U.S. Department of Commerce, 1995.

________. *U.S. Consumer Research Initial Trend Analysis 1995: Nautical Report, prepared by Strategy, Research and Action, Ltd.* London: Strategy, Research and Action, Ltd., 1995.

National Ocean Service. *National Ocean Service Fiscal Year 1996 Annual Operating Plan (draft).* Washington, D.C.: U.S. Department of Commerce, 1996.

National Spatial Reference System Preservation Process Action Team. *Final Report Submitted to the Executive Steering Committee.* Washington, D.C.: National Spatial Reference System Preservation Process Action Team, 1996.

Office of Aeronautical Charting and Cartography. *Task Codes.* Washington, D.C.: Office of Aeronautical Charting and Cartography, 1995.

U.S. Department of Defense

U.S. Department of Defense. *Global Positioning System User Charges: A Report to the Senate and House of Representatives Committees on Appropriations and Armed Services.* Washington, D.C.: U.S. Department of Defense, 1984.

________. Defense Mapping Agency. *Reinvention Concepts for the Defense Mapping Agency: Responsive Today . . . Ready for Tomorrow.* Washington, D.C.: DMA Reinvention Task Force, 1995.

________. Tri-Service CADD/GIS Technology Center. *Tri-Service Standards (draft).* Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station, 1995.

________. Defense Science Board, *Report of the Defense Science Board Task Force on Defense Mapping for Future Operations,* Office of the Undersecretary of Defense for Acquisition and Technology, September, 1995.

________. Defense Science Board, *Report of The Defense Science Board Task Force on Outsourcing and Privatization.* Office of the Undersecretary of Defense for Acquisition and Technology, 1996.

U.S. Departments of Defense and Transportation. *The Global Positioning System: Management and Operation of a Dual Use System.* Washington, D.C.: U.S. Departments of Defense and Transportation, 1993.

U.S. Department of Housing and Urban Development

Cisneros, Henry. *Renewing America's Communities from the Ground Up (draft).* Washington, D.C.: U.S. Department of Housing and Urban Development, undated.

U.S. Department of the Interior

U.S. Department of the Interior. *A Study of Land Information, Prepared in Accordance with Public Law 100-409, the Federal Land Exchange Facilitation Act of 1988.* Washington, D.C.: U.S. Department of the Interior, 1990.

________. U.S. Board on Geographic Names. *Authorities and Organizations Involved with Geographic Names: United States, Canada, Mexico.* Reston, VA: U.S. Department of the Interior, 1989.

________. Office of Audits and Investigation. *Review of Reimbursable Program, Office of Cadastral Survey, Denver Service Center, Bureau of Land Management.* Washington, D.C.: U.S. Board on Geographic Names, 1979.

________. Office of the Inspector General. *Audit Report: Mapping Activities, Bureau of Land Management.* Washington, D.C.: U.S. Department of the Interior, 1992.

White, C. Albert. *A History of the Rectangular Survey System.* Washington, D.C.: Government Printing Office, undated.

Bureau of Land Management

U.S. Department of the Interior, Bureau of Land Management, *Blueprint for the Future,* September, 1994.

________. *Cadastral Survey Strategic Plan,* March, 1994.

________. *Managing our Land Information Resources,* BLM-AA-AE-89-0003-4540, May 1989.

________. Resource Mapping Support Study for the BLM's Land Information System, September 1989.

________. *Cadastral Survey Customer Questionnaire.* Washington, D.C.: U.S. Department of the Interior, 1994.

________. *The Geo-Positioning Selection Guide for Resource Management: Technical Note 389.* Washington, D.C.: Department of the Interior: 1993.

________. *Manual of Surveying Instructions.* Washington, D.C.: U.S. Government Printing Office, 1973.

________. *Public Land Statistics 1993.* Washington, D.C.: U.S. Department of the Interior, 1994.

________. *Public Land Statistics 1994–1995.* Washington, D.C.: U.S. Department of the Interior, 1996.

________. *Response of the Bureau of Land Management to the House Appropriations Investigations Staff Report, "Cadastral Survey Programs of the Department of the Interior and the U.S. Forest Service.* Washington, D.C.: U.S. Department of the Interior, 1979.

________. *Review of the Cadastral Survey Program: Director's Report.* Washington, D.C.: U.S. Department of the Interior, 1980.

U.S. Geological Survey

U.S. Geological Survey. *Summary of the USGS Strategic Plan.* June, 1996.

________. *Strategic Plan for the U.S. Geological Survey: 1996 to 2005.* May, 1996.

________. *Aerial Photographs and Satellite Images.* Washington, D.C.: U.S. Geological Survey, 1995.

________. *EROS Data Center Annual Report of Data Services Fiscal Year 1996,* prepared by Nancy Schultz, Information Specialist, HSTX, Data Services Branch, Customer Services, EROS Data Center, Sioux Falls, SD.

________. *Historical Landsat Data Comparisons.* Washington, D.C.: EROS Data Center, 1995.

________. *Strategic Plan for the National Mapping Division.* Washington, D.C.: U.S. Geological Survey, 1997.

________. *USGS Maps.* Washington, D.C.: U.S. Geological Survey, 1995.

________. National Mapping Division. *National Mapping Division Strategic Plan.* Washington, D.C.: U.S. Department of the Interior, 1997.

U.S. Department of Justice

U.S. Department of Justice, National Institute of Corrections. *Program Review and Internal Audit in Corrections.* Washington, D.C.: U.S. Department of Justice, 1994.

________. Office of the Inspector General. *Office of the Inspector General: Semiannual Report to Congress.* Washington, D.C.: U.S. Department of Justice, 1997.

U.S. Department of Transportation

U. S. Coast Guard. *Boating Statistics 1994.* Washington, D.C.: U.S. Department of Transportation, 1995.

Nongovernmental/Nonprofit studies

Advisory Commission on Intergovernmental Relations. *Directory of State-Local Relations Organizations: The ACIR Counterparts.* Washington, D.C.: U.S. Advisory Commission on Intergovernmental Relations, 1990.

________. *Statement: Workgroup on State and Local Partnership with the Federal Geographic Data Committee.* Washington, D.C.: U.S. Advisory Commission on Intergovernmental Relations, 1993.

American Congress on Surveying and Mapping and American Society for Photogrammetry and Remote Sensing. *1997 Annual Convention and Exposition Technical Papers, Volumes 1–6.* Bethesda, MD: ASPRS and ACSM, 1997.

American Consulting Engineers Council. *Negotiating for Design Professional Services: Estimating, Negotiating, Contracting.* Washington, D.C.: American Consulting Engineers Council, 1997.

Booz Allen and Hamilton. *North American GPS Markets: Analysis of S/A Policy Alternative: Presentation to National Academy of Sciences Committee on the Future of the Global Positioning System.* Washington, D.C.: Booz Allen and Hamilton, 1994.

Buehler, Kurt and Lance McKee, eds. *The OpenGIS Guide: Introduction to Interoperable Geoprocessing.* Wayland, MA: Open GIS Consortium, Inc., 1996.

Carnegie Commission on Science, Technology and Government. *Environmental Research and Development: Strengthening the Federal Infrastructure.* New York: Carnegie Corporation of New York, 1992.

________. *Science, Technology, and Congress: Organizational and Procedural Reforms.* New York: Carnegie Corporation of New York, 1994.

________. *Science, Technology, and Government for a Changing World.* New York: Carnegie Corporation of New York, 1993.

Clarke, Jeanne Nienaber and Daniel C. McCool. *Staking Out the Terrain: Power and Performance Among Natural Resource Agencies,* second edition, State University of New York Press, New York, NY, 1996.

Chartrand, Robert and K.C. Chartrand. *Strategies and Systems for Disaster Survival.* Rockville, MD: Research Alternatives, Inc., published for the Symposium on Information Technology and Emergency Management, 1988.

Epstein, Earl and Thomas Duchesneau. *The Use and Value of Nautical Chart Information.* ME: University of Maine, 1987.

Hurn, Jeff. GPS: *A Guide to the Next Utility.* Sunnyvale, CA: Trimble Navigation, 1989.

Intelsat. *Agreement Relating to the International Telecommunications Satellite Organization.* Washington, D.C.: Intelsat, 1973.

Logsdon, Tom. *The Navstar Global Positioning System.* New York: Van Nostrand Reinhold, 1992.

Management Association for Private Photogrammetric Surveyors. *Contract with America's Mapping Firms.* Reston, VA: Management Association for Private Photogrammetric Surveyors, date not available.

________. *1995 Member Firm Capability Study.* Reston, VA: Management Association for Private Photogrammetric Surveyors, 1995.

National Academy of Public Administration

National Academy of Public Administration, *Organizing the Administration of Surface Transportation Policies and Programs to Meet National Needs.* Washington, D.C.: National Academy of Public Administration, August 1991.

________. *Coping with Catastrophe: Building an Emergency Management System to Meet People's Needs in Natural and Manmade Disasters.* Washington, D.C.: National Academy of Public Administration, 1993.

________. *Federal Government Restructuring Programs.* Washington, D.C.: National Academy of Public Administration, 1996.

________. *A Performance Based Organization for Nautical Charting and Geodesy.* Washington, D.C.: National Academy of Public Administration, 1996.

________. *Review of Actions Taken to Strengthen the Nation's Emergency Management System: A Study for the Federal Emergency Management Agency.* Washington, D.C.: National Academy of Public Administration, 1994.

________. *Survey of State and Local Government Use of Benchmarking for Public Works Infrastructure.* Washington, D.C.: National Academy of Public Administration, 1996.

National Academy of Public Administration/National Research Council. *Charting the Future: The Global Positioning System.* Washington, D.C.: National Academy of Public Administration, 1995.

National Research Council

National Research Council. *Need for a Multipurpose Cadastre.* Washington, D.C.: National Academy Press, , 1980.

________. *Spatial Data Needs: The Future of the National Mapping Program.* Washington, D.C.: National Academy Press, 1990.

________. *The Future of Spatial Data and Society: Summary of a Workshop* (Prepublication version), Mapping Science Committee, Board of Earth Sciences and Resources, Commission on Geosciences, Environment, and Resources. Washington, D.C.: National Academy Press, 1997.

________. *Charting a Course into the Digital Era: Guidance for NOAA's Nautical Charting Mission.* Washington, D.C.: National Academy Press, 1994.

________. *A Data Foundation for the National Spatial Data Infrastructure.* Washington, D.C.: National Academy Press, 1995.

________. *Federal Surveying and Mapping: An Organizational Review.* Washington, D.C.: National Academy Press, 1981.

________. *Forum on NOAA's National Spatial Reference System.* Washington, D.C.: National Academy Press, 1994.

________. *Geologic Mapping, Future Needs,* 1988.

________. *Modernization of the Public Land Survey System.* Washington, D.C.: National Academy Press, 1982.

________. *Promoting the National Spatial Data Infrastructure Through Partnerships.* Washington, D.C.: National Academy Press, 1994.

________. *A Review of the U.S. Global Change Research Program and NASA's Mission to Planet Earth/Earth Observing System.* Washington, D.C.: National Academy Press, 1995.

________. *Review of NOAA's Fleet Replacement and Modernization Plan*. Washington, D.C.: National Academy Press, 1994.

________. *Setting Priorities for Land Conservation*, 1993.

________. *Toward a Coordinated Spatial Data Infrastructure for the Nation*. Washington, D.C.: National Research Council, 1993.

________. *Technical Issues in NOAA's Nautical Chart Program*. Washington, D.C.. National Academy Press, 1996.

Renewable Natural Resources Foundation. Congress on Implications of Geographic Information Systems to the Sustainability of Renewable Natural Resources. Bethesda, MD, Renewable Resources Journal, Autumn, 1996.

University Consortia for Geographic Information Science. 1997 Research Priorities, 1996.

Other

Foresman, Timothy W., Editor, The History of Geographic Information Systems: Perspectives from the Pioneers, Upper Saddle River, New Jersey: Prentice-Hall, Inc., 1998. (forthcoming)

GIS World. GIS in Government: The Federal Perspective, 1994. Fort Collins, CO, GIS World Books, 1995.

Rettie, Dwight. *Our National Park System*. Chicago: University of Illinois Press, 1995.

Schlesinger, James. "GPS-The *Ultima Thule* of Navigation." Presented at the Eighth International Technical Meeting, the Satellite Division of The Institute of Navigation: 1995.

Stasz, Cathleen, Tora Bikson, et al. *A RAND Note: Assessing Benefits of the U.S. Forest Service's Geographic Information System: Research Design*. Santa Monica, CA: RAND, 1991.

Vickerman, Sara and Kent Smith. *Recommendations for Implementing Gap Analysis (draft)*. Lake Oswego, Oregon: Defenders of Wildlife, 1995.

International

Ackroyd, Neil and Robert Lorimer. *Global Navigation: A GPS User's Guide*. London: Lloyd's of London Press, Ltd., date not available.

Rhind, David (ed.), *Framework for the World*. Cambridge, U.K.: GeoInformation International, 1997.

World Conservation Monitoring Centre. *Guide to Information Management in the Context of the Convention on Biological Diversity*. Nairobi, Kenya: United Nations Environment Programme, 1996.

Canada

"Working with Industry to Deliver the Federal Geomatics Program," J. Hugh O'Donnell, Assistant Deputy Minister, Surveys, Mapping and Remote Sensing Sector, Natural Resources Canada, presented at Outsourcing Government Programs and Administrative Functions, Public/Private Partnerships for Reduced Costs and Improved Service, Ottawa, Ontario, November 29, 1993.

Booz Allen and Hamilton, Ltd. *Vision and Strategy for the Geodetic Survey Division, Geomatics Canada.* Ottawa, Ontario: Booz Allen and Hamilton, Ltd., 1995.

Canadian Coast Guard, Department of Fisheries and Oceans. *Public Consultation Paper: Proposed Options for a Marine Services Fee.* Ottawa, Ontario: Canadian Coast Guard, 1995.

Geomatics Canada. *Annual Review 1993–1994.* Ottawa, Ontario: Natural Resources Canada, 1994.

________. *Memorandum of Understanding between Geomatics Canada and the Department of National Defence.* Ottawa, Ontario: Geomatics Canada, 1995.

Natural Resources Canada, Earth Sciences Sector. *Strategic Overview Document.* Ottawa, Ontario: Natural Resources Canada, 1996.

Surveys, Mapping and Remote Sensing Sector. *Annual Review 1991–1992.* Ottawa, Ontario: Energy, Mines and Resources Canada, 1992.

________. *Annual Review 1992–1993.* Ottawa, Ontario: Energy, Mines and Resources Canada, 1993.

Terry, Brian and Neil Anderson. *A Canadian Public/Private Sector Initiative for the Production and Distribution of Electronic Charts.* St. John's, Newfoundland and Ottawa, Ontario: Nautical Data International, Inc. and Canadian Hydrographic Service, undated.

United Kingdom

Coopers and Lybrand. *Economic Aspects of the Collection, Dissemination and Integration of Government's Geospatial Information.* Southampton, United Kingdom: Ordnance Survey, 1996.

Department of Environment: *Handling Geographic Information: Report of the Committee of Enquiry* chaired by Lord Chorley, 1987

Inmarsat General Counsel, ed. *Inmarsat Basic Documents, Fourth Edition.* London: Inmarsat, 1989.

Ordnance Survey. *Annual Report and Accounts 1995–1996.* Southampton, United Kingdom: Ordnance Survey, 1996.

________. *Mapping the Way to the Next Millennium: Ordnance Survey Strategic Plan 1996–2001.* Southampton, United Kingdom: Ordnance Survey, 1996.

________. *Results of the Consultation Exercise on the "National Interest in Mapping."* Southampton, United Kingdom: Ordnance Survey, 1996.

Media

Booth, Rick. "Private Sector Charts: Have They Grown Up?" *Practical Sailor* (January 1990): 9–13.

Enabnit, David. "NOS To Provide Vector Data Sets for ECDIS." *The Seahorse Newsletter* (Winter 1996-1997): 1–2.

Flemming, Nic. "Making the Case for GOOS." *Sea Technology* (date unknown).

Green, Kass. "Panacea or Pandora's Box? How New Satellites Will Affect Our View of the World." *Geo Info Systems* (July 1996): 12–20.

Henstridge, Fred. "Is ACSM Serving the Surveyor?" *Professional Surveyor (July/August* 1997): 58–60.

Howard, Charles. "Technologies Converging in Utilities." *Geo Info Systems* (July 1996): 21–23.

Jones, Jennifer, "Federal GIS Project Decentralize," *GIS World,* August, 1997.

Matsunaga, Keene and Dangermond, Jack, *Promoting Free Access or Minimal Cost Dissemination Arrangement for Government-Held Geographic Information Systems Data,* Environmental Systems Research Institute, Inc. February, 1997.

Montgomery, Hale. "Baltimore County, Digitized; Low Cost Space Messages; Time to Fold." *GPS World* (January 1996): 12, 14.

Noll, Roger. "The Economics of Information: A User's Guide." *Annual Review of Institute for Information Studies* (1993–1994): 25–52.

Onsrud, Harlan, J., Johnson, Jeffrey, and Winnecki, Judy, *GIS Dissemination Policy: Two Surveys and A Suggested Approach,* URISA Journal,

Perritt, Henry. "Should Local Governments Sell Local Spatial Databases Through State Monopolies?" *Jurimetrics Journal* 35 (1995): 449–469.

Wilcox, Douglas J. "Proposed Map Accuracy Standards for a Multipurpose Cadastre." *Computer, Environmental, Urban Systems* 9 (1984): 203–207.

Warnecke, Lisa, *Geographic Information/GIS Institutionalization in the 50 States: Users and Coordinators,* Santa Barbara, CA, National Center for Geographic Information and Analysis, September, 1995.

________. "GI-GIS Projects in the Field: Overcoming the Government Maze," *Geo Info Systems,* October 1995 pp 34–43.

________. *NASA as a Catalyst: Use of Satellite Data in the States,* Washington, DC: NASA, 1997.

Warnecke, Lisa, et al.. *State Geographic Information Compendium.* Lexington KY: The Council of State Governments, 1992.

________. Warnecke, Lisa, Beattie, Jeff , Kolin, Cheryl, and Lyday, Winifred "Geographic Information Technology in Cities and Counties: A Nationwide Assessment", Washington, D.C.: American Forests (1998)

Wood, William B., A Jeffersonian Vision for Mapping the World, Issues in Science and Technology, Fall, 1997.

State

Governor's Office of Emergency Services (California). *Emergency Services Act: Chapter 7 of Division 1 of Title 2 of the Government Code.* Sacramento: Department of General Services, 1995.

Pickles, John, *Ground Truth: The Social Implications of GIS,* The Guilford Press, NY, 1995.

Reece, David A. and Spiers, James, *Utility Market Changes, Local Government and the Role of GIS,* Englewood, CO: UGC Consulting, 1995.

Stevenson, Paula J. and Bossler, John D., An Ad-Hoc Review of Research Needs of Selected Federal Mapping Agencies, Columbus, OH: Ohio State University, May, 1997

Oregon Biodiversity Project. *Oregon Biodiversity Project: A Cooperative Effort to Develop a Statewide Biodiversity Management Strategy.* Lake Oswego, OR: Oregon Biodiversity Project, 1996.

Utah, Department of Administrative Services. *Utah State Geographic Information Database Users Guide, Ninth Edition.* Salt Lake City, UT: Automated Geographic Reference Center, 1996.

Washington, Department of Information Services. *The Newest Frontier (videotape).* Olympia, WA: Washington Interactive Television, 1996.

Local

National League of Cities, *Planning Smarter, Geographical Information Systems as a Tools for Policymakers, Issues and Options,* Volume 1, Number 4.

APPENDIX I

Relationship Between Public Purposes and Geographic Information

In reevaluating current federal mapping, surveying, charting, and other geographic information roles, it is important to consider whether the public purposes they support remain inherently governmental and essential to the nation's well being and continued competitiveness in today's rapidly globalizing economy.

As mentioned in Chapter Three, the constitutional and legislated purposes of the federal government have created at least 12 major program areas that rely on geographic information. These program areas rely on multiple types of geographic information.

The following descriptions of these 12 geography-related public purposes provide additional detail about the nature of the federal mission and how it relates to the economy and to the activities of the other levels of government.

PROPERTY RIGHTS AND VOTING RIGHTS

Constitutional guarantees of the right to own property and to be able to vote on a "one person, one vote" basis for the public officials who govern us are essential foundations of America's private economy and representative democracy. These rights are represented on maps of property lines, political boundaries, voting districts, and statistical units such as census blocks and tracts. Many of these types of boundaries follow transportation rights-of-way, water courses, and the shorelines of water bodies. These officially recorded boundaries underpin the nation's real estate industry and many of its political and statistical activities.

Because the vast majority of U.S. territory was acquired by the federal government before it was transferred to present-day owners, the Public Land Survey System, now maintained by the Bureau of Land Management, is the original basis for most of the nation's land records. For the most part, present day land records systems are operated by local governments in accordance with state laws. In most states, counties are the local governments in charge of recording real estate transactions and new land surveys. Most such surveys are made by private, state-licensed surveyors.

In western states, where large portions of the territory are still federally owned, the major federal land-owning agencies (principally the Bureau of Land Management and the Forest Service) have major land surveying programs on their own lands, and important roles in resolving land disputes between federal and nonfederal land owners, and between holders of conflicting land claims recorded by the federal government. This property dispute resolution role frequently requires reference to historical land records held by the federal government.

The key to fitting all these property surveys together is geodetic control. This system of locating points horizontally (latitude and longitude) and vertically (elevations and depths below water) on the surface of the earth is provided by the National Ocean Service of NOAA (Department of Commerce).

The relatively recently developed Global Positioning System (GPS) has made the use of geodetic control much more readily available for many GIS applications. Expected improvements in accuracy within the near future will make GPS even more widely applicable to surveying and many other public and private programs.[1]

State boundaries are guaranteed inviolate by the U.S. Constitution, and local government boundaries (including counties, municipalities, towns, special districts, and school districts) are established and changed under the conditions established by state constitutions and laws. The boundaries of Indian tribal governments are established by treaties with the U.S. government. Voting districts for federal, state, and local elections are established and changed by the states under the watchful eye of the federal courts which have responsibility for guaranteeing one person, one vote equity in voting rights. International boundaries are the responsibility of the U.S. Department of State.

REVENUES FROM PROPERTY

Real estate property taxes are mainstays of most local government revenue systems, and still produce limited revenues for some states. Property-owner parcel maps are essential as the basis for keeping track of and properly assessing the value and tax liability of real estate.

In addition, the state and federal governments derive revenues from private sector extraction of natural resources and other uses of public lands. The federal government also retains mineral and oil rights to certain lands that have been deeded to private owners, and to off-shore underwater lands. Furthermore, some states use severance taxes that tax the extraction of minerals, oil and other natural resources from lands within the state. Thus, accurate records of land ownership, land leases, and amounts of natural resources removed are critical contributors to public finance systems.

TRANSPORTATION, NAVIGATION, AND COMMERCE

The National Ocean Service, a component of the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), supplies the nation's nautical and air navigation charts. The Army Corps of Engineers supplies water navigation charts for ports and inland waterways.

Rapid increases in international trade and air travel are putting pressure on these agencies to maintain these vital navigation charts up to date even as their resources diminish. As increased volumes of toxic and environmentally dangerous materials have come to be transported, concerns about widespread health and environmental consequences of accidents have been added to traditional concerns about the losses of lives and property directly involved in accidents.

Federal planning requirements for federally aided state and metropolitan transportation planning agencies has become much more complex, demanding, and data intensive in recent years.[2] In addition to geographic information about transportation facilities and equipment, large quantities of geographic information are required now about such matters as land use, demographic and social characteristics of the populations served, air quality, congestion management, water quality, ecosystem management, service outcomes for various types of customers, and customer satisfaction. Freight, as well as passenger, transportation systems must be addressed, including issues such as meeting the increased demands of the business sector for just-in-time delivery of materials to minimize warehousing costs.

These transportation planning programs are paying for the development and maintenance of many geographic information systems and traffic simulation models to support long range transportation planning and short-term transportation management plans. Census and environmental data are as important in these federally required planning processes as the transportation system data themselves. DOT pays the Census Bureau to collect extra data for the use of the state and metropolitan planners it funds, and prepares special Census planning data packages for them. It also works with EPA to provide air quality planning packages to help process relevant geographic information.

Increased emphasis on public involvement in transportation planning since enactment of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) has created pressure to open the state and local planning processes, and the geographic information systems on which they are based, to public view, and to support more intensive and interactive forms of public involvement in transportation planning.[3]

PUBLIC LAND AND MARINE SANCTUARY MANAGEMENT

The federal government currently owns, and is responsible for managing about 30 percent of the nation's territory. These management responsibilities have become more demanding in recent decades as a wide variety of environmental concerns have been required. Such new responsibilities as multi-purpose use, sustained yield, endangered species protection, pollution control, toxic clean-ups, ecosystem management, and sustainable development have multiplied the geographic information needs of federal land managers.

The primary federal agencies subject to these demands are BLM, the Forest Service, the National Park Service, the Fish and Wildlife Service, the Department of Defense, and the Bureau of Reclamation. Similar responsibilities also apply to state, local, and tribal land managers.

This function of government can beneficially use all the common types of geographic information. Thus, public land managers at all levels of government are among the officials with the greatest need to integrate geographic information from a variety of sources. They also are likely to have to take responsibility for mapping their own lands because of the great expanse of their holdings over which no one else would have an economic incentive to map.

AGRICULTURE AND NATURAL RESOURCE DEVELOPMENT

The federal government has a long-standing and strong interest in development and use of the nation's land and water resources. This interest goes back to the beginning of the nation when the government acquired the lands west of the original 13 states and systematically disposed of over half of that acreage to homesteaders, miners, railroads, timber companies, other private interests, and the states to promote development and economic activity. About 80 percent of these lands went into private ownership, as described more fully in Appendix E.

In addition to making the land available for private use, the federal government encourages full economic use of these lands by providing assistance to private landowners in the form of technical information and expertise, public water and power, rural electrification and telephone service, transportation facilities, and leasing of oil and mineral rights retained by the government when the lands were transferred to private ownership.

In recent years, federal environmental protection, natural resource conservation, and ecosystem protection programs have modified the policies of full economic use. Now, the objective follows a more balanced set of multiple-use and sustainable development principles.

ENVIRONMENTAL PROTECTION AND ECOSYSTEM MANAGEMENT

Federal laws have applied environmental protection and ecosystem management principles nationwide —not just to public lands but to private lands as well. Thus, many of the laws that have complicated the responsibilities of public land managers also affect private land owners and the federal, state and local regulators responsible for working with them. These groups also need the widest range of geographic information, and have the greatest need to integrate diverse data bases into a consistent system.

EPA, NOAA, USDA, and Interior have the greatest federal expertise in, and responsibility for, this function.

The nation's air and water are getting demonstrably cleaner, the handling of toxics is becoming more careful, toxic environments are beginning to be cleaned up, and ecosystem management is starting to benefit biodiversity and sustainable development goals because of federal environmental protection requirements enacted since 1969. But, as a result, the processes of reviewing physical development proposals and infrastructure projects has lengthened dramatically.

One reason for these delays is that the geographic information needed to support better environmental analysis and decisionmaking is hard to find and to integrate. It comes from diverse sources, is recorded at different scales, and often has gaps that impede sound analysis. Thus, the accuracy and adequacy of the data often are challenged as well as the interpretations placed on them by different parties who would be affected by the outcomes. On top of the technical analysis and political decisionmaking processes, which may be very lengthy in many cases, judicial proceedings frequently are added. In the end, it is not unusual for the federally required environmental review process to take longer than implementation of the proposed project itself.[4]

Adding still further to the demands for geographic analysis is Executive Order 12898 (February 11, 1994) which requires an analysis of environmental and social justice issues surrounding the spending of federal funds to ensure that a pattern of discrimination against neighborhoods of lower income and disadvantaged people does not occur in the future and is reversed where it already has occurred. HUD, as mentioned in the next section, has begun to supply geographic information to many of its grant recipients to support this new type of analysis, and U.S. DOT held a conference on ways to apply the executive order to transportation programs. This rule requires comparative analysis of environmental and social impacts of past and proposed federal and federally assisted projects neighborhood-by-neighborhood – a highly intensive use of integrated geographic information.[5]

COMMUNITY AND ECONOMIC DEVELOPMENT

HUD, USDA, and the Department of Commerce administer programs designed to assist needy neighborhoods and communities to improve their physical environments, economic opportunities, and quality of life characteristics. These federal-aid programs require planning based on analysis of multiple types of geographic information, and careful monitoring of conditions resulting from the use of federal funds. HUD has begun to offer its program clients a variety of Census-based geographic information files in electronic form to facilitate the required planning. HUD funding also has assisted many communities to develop local government geographic information systems (GIS) for over two decades.

For an even longer time, HUD has promoted the adoption of zoning, subdivision, building, and occupancy codes designed to improve the safety and quality of life in urban America. These codes put many local governments in charge of transactions that produce geodata which can be used to update geographic information systems when streets are built, buildings are constructed or altered, and new public works are added.

EMERGENCY MANAGEMENT

The Federal Emergency Management Agency (FEMA) has nationwide responsibility for helping to reduce losses from natural hazards, disasters, civil disturbances, and military or terrorist attacks on U.S. territory. These responsibilities require prevention, preparedness, response, and recovery capabilities.

Since the events that trigger a FEMA response are all place-specific, this agency's mission is highly geographic. Its substance covers such geographic conditions as flood plains, seismic and volcanic risk zones, other natural hazard risk zones including weather-related danger areas, and hazardous materials or toxic spill locations. Evacuation routes are a significant concern in many areas.

In preparation for events requiring a response, FEMA is developing GI systems for both (1) loss reduction and readiness planning, and (2) response management. The response management GIS is designed to link 27 federal agencies to each other to the state and local response units.

PUBLIC SERVICE DELIVERY

Many routine public services can be delivered more efficiently when planned so that service delivery facilities are optimally located in proximity to the clienteles and areas needing services, and so that available vehicles are routed most efficiently. GIS techniques facilitate this type of planning when the service demand and supply information is accurate and up-to-date.

Examples of this type of GIS-assisted planning include the siting of schools, land fills, police and fire stations, community centers, hospitals, and health clinics; and the routing of buses, trash trucks, delivery trucks, police cars, fire trucks, and other emergency response vehicles. Enhanced 911 systems improve the effectiveness of this approach. Although most of these services are delivered locally, many of them involve federal aid.

GIS tools also are being used to monitor the performance of public service programs on a neighborhood-by-neighborhood basis. When different strategies are tried in different neighborhoods, the results can be compared among comparable areas to help determine what works best with different types of clientele.

Since federal-aid dollars from departments as disparate as Justice and Health and Human Services are involved in many of these programs, there is a federal interest in supporting these types of GIS in the most efficient way. General demographic data, specific case records, and information about transportation networks, together, enable GIS tools to improve public service delivery.

NATIONAL DEFENSE

The purpose of the Department of Defense National Intelligence and Mapping Agency (NIMA) is to provide reliable overseas navigation and targeting aids to the U.S. military. NIMA does not map U.S. territory. Instead, it relies on the civilian mapping agencies for domestic maps and navigation charts, and for many of the other types of geographic information Defense may need at its homeland installations and military reservations (such as environmental and ecological data). Thus, the U.S. military has a stake in the quality and timeliness of the nation's domestic geographic information resources.

EARTH SYSTEM SCIENCES AND GI TECHNOLOGIES

Many of the recent advances in domestic GIS have their roots in long-term basic research and civilian applications of military research. On the long-term research side, scientific advances in the fields of geodesy, seismology, geology, hydrology, and natural ecologies have been important. On the technology development front, computers, laser-beam surveying equipment, side-scanning sonar, GPS, remote imaging, and the Internet have contributed significantly to recent advances.

The National Science Foundation, NASA, USGS, NOAA, EPA, USDA, and the Defense Department are the major federal players. This is a role in which the federal government has distinct advantages. Few state and local governments support such activities.

PUBLIC INFORMATION

In addition to routinely providing traditional geographic information products (generally published maps) to the public to meet the wide variety of consumer and business needs referred to in Chapter Three, the new GIS technologies that public agencies are using are making it possible to provide much greater public access to government data than ever before. The data storage and transmission technologies needed to make much greater amounts of GI accessible to ordinary citizens (and the wide array of organizations representing them) already exist, but bringing the costs down and making them sufficiency user friendly for widespread use has been estimated to take another decade or so. This widespread sharing of GI with the public has been described recently as "among the most important issues now before the GIS community."[6]

The inherently graphic nature of GI, and its central importance to so many essential functions of government, may make it one of the most efficient means of raising the consciousness of citizens about many government activities, increasing their participation in government, making governments more responsive and accountable to citizens, improving the outcomes of government programs and citizen satisfaction, and increasing citizen support for government. In the words of one prominent member of the GIS community, "citizens and governments both can benefit."[7]

These benefits will not come, of course, without significant efforts by governments and the business suppliers of GIS and related information technologies. Budgets will need to be devoted to this issue, attitudes within governments may need to be changed to view this as a positive opportunity rather than a threat, and the public's understanding of these tools will need to be raised.

CONCLUSION

The bottom line is that the federal government is currently involved in many high profile and important public purpose missions that rely heavily on high quality and timely geographic information. In addition, many of these missions require the integration of several types of geographic information.

These missions are important to the efficient operation of large segments of the U.S. economy, including: real estate, construction, transportation and world trade, public works and utilities, minerals and oil development, forestry, agriculture, community and economic development, and the insurance industry (reducing losses from disasters and providing disaster assistance to supplement private insurance coverage).

Finally, it is clear that the federal, state, local, and other governments are routinely working with similar types of geographic information for similar purposes. Sometimes these data are shared, but often they are not. Additional opportunities for sharing geographic information might offer benefits to all parties.

ENDNOTES

[1] National Academy of Public Administration and National Research Council, *Charting the Future: The Global Positioning System* (Washington, DC: National Academy of Public Administration, May 1995).

[2] U.S. Advisory Commission on Intergovernmental Relations, *MPO Capacity: Improving the Capacity of Metropolitan Planning Organizations to Help Implement National Transportation Policies* (Washington, DC: May 1995). U.S. ACIR, *Planning Progress: Addressing ISTEA Requirements in Metropolitan Planning Areas* (Washington, DC: February 1997).

[3] Howard/Stein-Hudson Associates, Inc., and Parsons, Brinkerholf, Quade to Douglas, *Public Involvement Techniques for Transportation Decision-Making* (Washington, DC: Federal Highway Administration and Federal Transit Administration, September 1996). U.S. Advisory Commission on Intergovernmental Relations, *Planning to Govern* (Washington, DC: September 1994).

[4] U.S. Advisory Commission on Intergovernmental Relations, *Intergovernmental Decision-Making for Environmental Protection and Public Works* (Washington, DC: November 1992), pp. 1–5. See also, U.S. Advisory Commission on Intergovernmental Relations, *High Performance Public Works: A New Federal Infrastructure Investment Strategy for America* (Washington, DC: November 1993), p. 46.

[5] Federal Transit Administration, *Environmental Justice Report,* the proceedings of a November 1994 conference on Transportation, Environmental Justice, and Social Equity (Springfield, VA: National Technical Information Service, Summer 1995).

[6] Jack Dangermond, "Public Data Access: Another Side of GIS Data Sharing," in Harlan J. Onsrud and Gerard Rushton, eds., *Sharing Geographic Information* (New Brunswick, NJ: Center for Urban Policy Research, 1995), pp. 331–339.

[7] *Ibid.*, p. 338.

APPENDIX J

Comments of Sponsoring Organizations

ACSM

American Congress on Surveying and Mapping
5410 Grosvenor Lane, Bethesda, Maryland 20814
Phone: (301) 493-0200; Fax: (301) 493-8245

October 29, 1997

Edward E. David, Jr.
c/o National Academy of Public Administration
1120 G Street, N.W.
Suite 850
Washington, DC 20005

Dear Mr. David:

The American Congress on Surveying and Mapping (ACSM)[1] is pleased to submit comments on the final draft of NAPA's forthcoming study, **Geographic Information for the 21st Century: Building a Strategy for the Nation.**

Origin of the Study

As the draft report points out, ACSM has played a role as a catalyst, or facilitator, to bring this study into being. ACSM first recognized the need for a study in 1995, when Congress considered far-reaching proposals that included elimination or reassignment of key federal surveying and mapping functions and wholesale contracting out of agency geospatial data production to private firms. ACSM convened a focus group of leaders from the profession who suggested that Congress needed current, in-depth information on the capabilities and appropriate roles of agencies and private firms before acting to radically alter the existing structure. The panel also developed four questions that became the focus of the study and identified NAPA as the appropriate policy analysis organization to conduct the study.

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[1] ACSM is an individual membership society that represents more than 7,500 professionals in the fields of surveying, cartography, geodesy, and geographic information systems technology who work in both the public and private sectors throughout the world. ACSM is made up of four member organizations that serve as special interest groups. ACSM's member organizations are the American Association for Geodetic Surveying, the Cartography and Geographic Information Society, the Geographic and Land Information Society, and the National Society of Professional Surveyors.

In commenting on public issues, ACSM seeks to represent the interests of its private- and public-based members, the surveying and mapping profession as a whole, and the nation's long-term interest in ensuring the availability of comprehensive, timely, accurate, and useful geospatial information.

ACSM's Board of Direction endorsed the study initiative in August 1995. ACSM staff then approached a number of federal surveying and mapping agencies as potential sponsors. Four key agencies agreed to sponsor the analysis -- the U.S. Geological Survey, the Bureau of Land Management, the National Ocean Service, and the U.S. Forest Service. ACSM and the four agencies then worked with NAPA staff to develop a scope of work for the study. Funding commitments and a contract were made final, and the study officially began in October 1996. ACSM appreciates that NAPA invited ACSM staff, along with representatives of the sponsoring agencies, to serve as an advisory panel throughout the course of the study.

The Draft Report's Findings and Recommendations

ACSM commends the NAPA expert panel and staff for capturing the scope and complexity of geographic information, as well as the field's growing importance to the nation's economy. The study provides an array of long-term and short-term options that will prove valuable to Congress and the administration as they consider policy changes needed to create the National Spatial Data Infrastructure (NSDI) and to maintain an appropriate balance between government's role as steward of the nation's geospatial infrastructure and the growing production capabilities of private surveying and mapping firms.

In view of ACSM's role as catalyst of the study, and because ACSM's members work in both the private and public sectors (including many who work in the four sponsoring agencies), it would be inappropriate for our association to endorse or criticize recommendations in the study that are potentially divisive.

For example, the proposed consolidation of geographic information activities that currently are housed in different federal agencies into a Geographic Data Service (GDS) could aid creation of the NSDI by improving data sharing across the federal government, and between the federal government and other levels of government and the private sector. However, NAPA acknowledges that transition to the GDS could, in the short term, hinder existing agencies' efforts to meet their core missions. ACSM welcomes the suggestion for creation of a GDS, but believes the pros and cons of this proposal must be carefully weighed in the arena of public debate.

Similarly, the proposed transfer of the National Geodetic Survey from the Department of Commerce to the U.S. Geological Survey in the Department of the Interior has both positive and negative implications. This suggestion also merits thoughtful debate before any change is made.

Because of its commitment to finding ways to serve the public in the most cost effective manner, ACSM was particularly interested in the study's findings on public purpose (Chapter 3) and balancing public and private sector roles and functions (Chapter 6). The issues addressed in these chapters are central to the study because it was Congress' consideration of proposals to radically alter the current balance of public and private sector responsibilities that led ACSM to suggest the need for a comprehensive study. These are also the issues that Congress and the administration are most likely to look at in the short-term as they continue to reduce the size and scope of the federal government and transfer more responsibilities and activities to other levels of government and the private sector.

The draft study suggests that:

> **Outsourcing decisions should be made on the basis of the respective roles, responsibilities, and competencies of the governmental and private sectors. Cost effectiveness is one of several factors that needs to be considered; on the other hand, arbitrary percentage targets for contracting out should be avoided.**

Technological advances in the last twenty years have given private firms the ability to perform surveying and mapping tasks that previously only government agencies could complete. It is also true that many of the technical advances in the profession, particularly in the field of geographic information systems, or GIS, are occurring in the private sector. ACSM recognizes and applauds those realities.

However, ACSM would point out that government ultimately is responsible -- and accountable -- for meeting the nation's need for accurate geospatial data that is produced in a timely, cost-effective manner. This stewardship role dictates that agencies retain in-house technical expertise and some production to ensure that contractors' products meet quality standards. In-house staff also are needed for contract negotiation and administration, preparation of government-supplied materials, and quality assurance. Agencies also need to retain sufficient staff and expertise to complete surveying and mapping tasks that private firms cannot yet carry out or that are not viewed as commercially viable.

NAPA's draft study recognizes both the growing capabilities of private firms and government's responsibility to retain the resources, technical skills, and personnel to administer private contracts and oversee contractor performance. The study intentionally avoids any philosophical discussion of the roles of government and the private sector in geographic information, choosing instead to focus on specific public purposes, such as protection of the environment. That is understandable from the perspective of the study's goal of producing specific recommendations for policymakers to consider. At the same time, as Congress and the administration consider changes that, over time, could sharply downsize or dismantle surveying and mapping agencies and shift their responsibilities to the private sector, federal lawmakers likely will want to know whether such a move is ultimately in the public interest.

Conclusion

ACSM believes NAPA's analysis of U.S. geographic information resources includes findings and recommendations that merit extensive discussion by lawmakers, the surveying and mapping profession, and other interested parties. As with all such analyses, the recommendations in this study are only the starting point. After the study is published, responsibility will shift to the profession and to policymakers to carefully consider NAPA's recommendations and to work to achieve consensus and implement some or all of the proposals.

ACSM commends the NAPA expert panel and staff for their work in producing a comprehensive study that forms the basis for future discussions and decisions affecting the nation's geographic information resources. In keeping with its role as an individual membership society that seeks to represent the long-term interests of both private and public sector surveyors and mappers, as well as the national interest in the area of geospatial information, ACSM looks forward to continuing to play a role in facilitating the debate on the NAPA findings.

Several weeks ago, ACSM submitted technical comments on the draft report as a first step in the review process. ACSM's government affairs committee discussed the draft report at a recent meeting and raised concerns about several passages that relate to the surveying and mapping profession and other issues. We believe these passages should be revised before the report is made final. We will forward these concerns to the NAPA project team as additional technical comments as soon as possible.

Again, ACSM appreciates the opportunity to comment on the forthcoming study. If you have questions or need more information on any issue in our comments, please contact Joseph Kuchler, ACSM Government Affairs Director, at 301-493-0200.

Sincerely,

Jud S Rouch

Jud S. Rouch
President

March 3, 1849

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Washington, D.C. 20240

NOV 12 1997

In Reply Refer To:
1430 (350)

Mr. Roger Sperry
National Academy of Public Administration
1120 G Street, N.W., Suite 850
Washington, D.C. 20005-3801

Dear Mr. Sperry:

The Bureau of Land Management (BLM) appreciates the opportunity to respond to the National Academy of Public Administration draft report titled, "Geographic Information for the 21st Century - Building a Strategy for the Nation."

As indicated in our October 27, 1997, technical comments, we believe the report draft has shortcomings in factual information and did not provide a logical consistent analysis in support of many of the recommendations. It is difficult to provide policy comments on a draft of uneven quality which we understand to be undergoing possible substantial revision. Nevertheless, in deference to your timetable, we offer the following comments based strictly on the draft report submitted to BLM on September 24, 1997.

Although we support some of the recommendations in the draft study report, we disagree with the recommendation to establish or consider establishing the proposed Geographic Data Service (GDS) and with some of the other recommendations. In addition to consolidating some Federal mapping functions, the GDS recommendation would incorporate cadastral survey and public land records functions as part of the mission of the proposed new organization.

The BLM and its predecessor agency, the General Land Office (GLO), have been responsible by law for the cadastral survey system and Federal public lands records for approximately 200 years. The report shows minimal understanding of the legal significance of cadastral survey and land records. Although BLM's modern mission in managing the public lands is much broader than the original GLO mission, survey and record functions remain essential in almost all of our day-to-day business. The draft study report, however, addresses land and title records and survey functions as if their collection, maintenance and use were independent of processing applications for using the public lands and making land management decisions on a daily basis. Additionally, the draft study report did not consider adverse impacts to the ongoing implementation of the Automated Land and Minerals Records System (ALMRS), a major automated systems investment which will provide for multi-agency access and updates to the land records, and vastly improved access for the general public.

The BLM is committed to continuing and expanding its leadership role in cadastral surveying and land title records and in supporting the National Special Data Infrastructure (NSDI). Shifting functions to a new agency will increase overhead costs, delay and jeopardize NSDI related accomplishments such as ALMRS implementation and create long-term issues by effectively splitting responsibility for the management of the public lands.

The specific comments on the major recommendations follow in three categories:

Recommendations the BLM can support, has committed resources towards achieving, or will make a concerted effort to achieve in the future.

1. Expanding the Geographic Coordinate Data Base.

   We support increasing this effort based upon customer needs and participation. National coverage of this critical layer of geographic information should be built in partnership based on the established priorities as set by the participants to meet the diverse and unique needs of each partner.

2. Crosscutting budget review of geographic information.

   The Office of Management and Budget should facilitate a review throughout the civilian sector of the Federal government to validate other recommendations within the report.

3. Strengthening the Federal Geographic Data Committee (FGDC).

   We believe strengthening the FGDC can be accomplished by greater emphasis of its role across all departmental levels to achieve consistent data standards and coordination of data requirements. This would include strengthening clearinghouse functions. The FGDC should focus on managing data for the entire user community. The current FGDC orientation towards base data would be improved if the FGDC addressed the full range of spatial data users.

4. Develop more partnerships to support the National Spatial Data Infrastructure (NSDI).

   We plan to continue to expand our role with the National Association of Counties, state and local governments and the private sector. Our intent is to increase emphasis on coordination with all users of cadastral survey and land records data beyond our over 200 agreements with county, state and federal governments recently negotiated.

5. Recommendation to improve Interior/military communication and coordination through the National Imagery and Mapping Agency and the National Aeronautics and Space Administration.

   The BLM has already benefitted from coordination with the Department of Defense through data collection efforts and technology transfer. We plan to substantially increase our cooperative efforts as evidenced by several ongoing projects.

Recommendations the BLM might support, if provided with further justification of their validity.

1. Proposal to consolidate surveyors into a single organization.

   The BLM and its predecessors are given the authority for Cadastral Surveys and Land Title Records. The BLM will continue to coordinate survey and land title records functions with other agencies. The ALMRS, when implemented, will provide for multi-agency access and updates to the land records. We believe the consolidation within the Department of the Interior requires further study and coordination with the Forest Service, National Park Service, Fish &Wildlife Service, and others. Physical consolidation would be costly and disruptive. The National Interagency Fire Center may serve as a model organization. We will continue as a leader in strengthening the Interagency Cadastral Coordination Council to satisfy multi-agency requirements.

2. Contract/subcontract more cadastral survey functions.

   The BLM will continue to pursue contractual efforts where cost effective and where contracts with private surveyors can meet the objectives of the mission. Further the BLM leads efforts in providing appropriate training for all surveyors to increase the skill level of land surveyors in conducting surveys within the Public Land Survey System.

3. Recommendation to consolidate base mapping and coordinate of acquisition of satellite imagery.

   National coordination of all imagery can not be justified on experience gained solely from the National Aerial Photography Program. This recommendation implies reliance on a third party and would be cumbersome, and in emergency situations such as wildland fire program support, could be disastrous. We suggest a focal point for acquiring imagery that can be planned in advance with all agencies required to report special use and emergency acquisitions to a clearinghouse.

Recommendations the BLM opposes because they are considered detrimental to the BLM's mission.

1. Need for NSDI legislation.

   We do not believe a new statute can successfully define the roles and responsibilities of the NSDI because of the complexities of geographic information and its integration within the mission or business functions of all organizations. Legislation could increase the bureaucracy unnecessarily. The BLM has contributed significantly to the broad spectrum of FGDC activities and will take steps to increase participation in the development of an NSDI.

2. Need for a National Spatial Data Council (NSDC).

   The NSDC as presented is not structured to allow for free participation of all users of geographic information, products and services. There is potential for a conflict of interest in building standards to fit software.

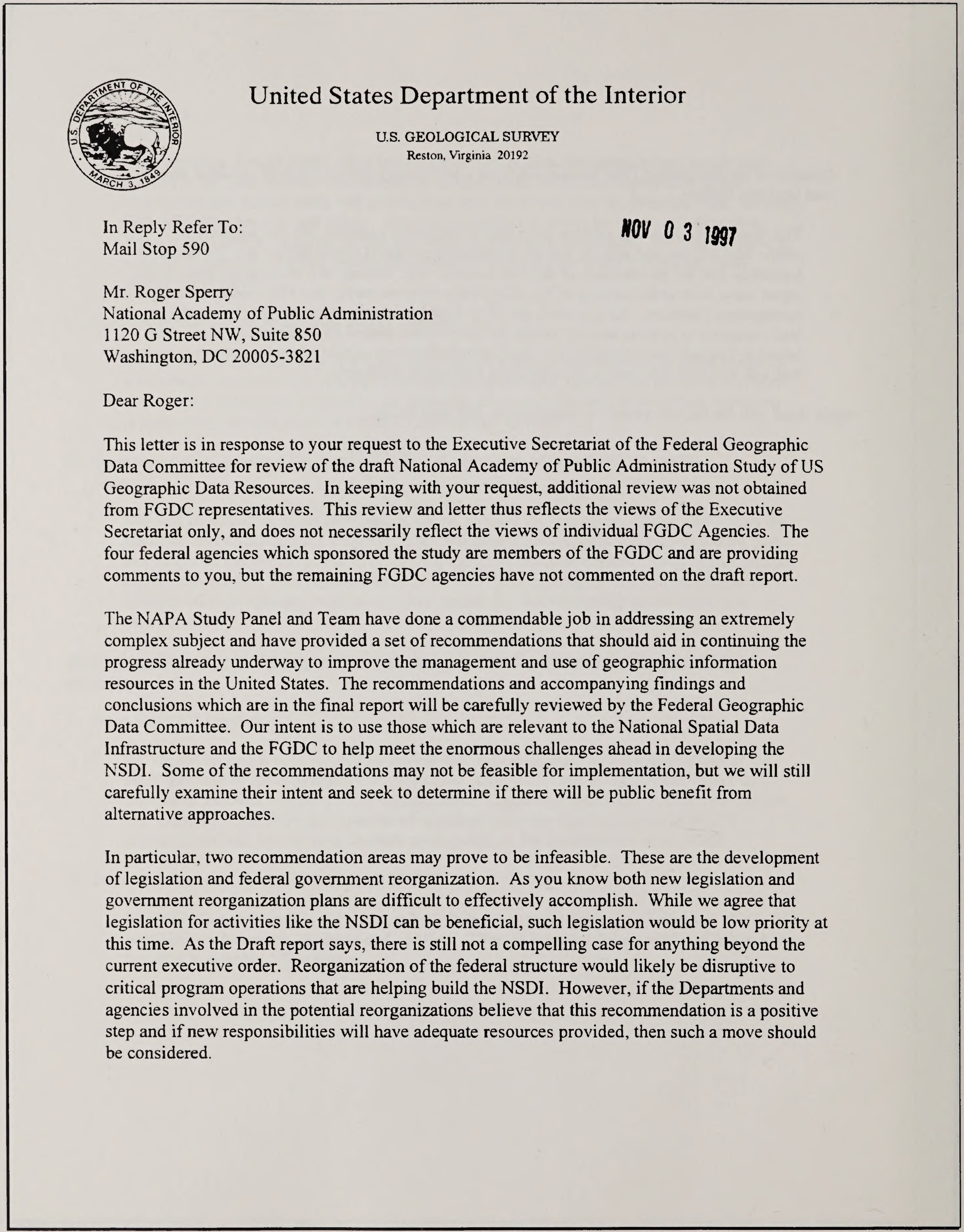
3. Creation of the Geographic Data Service (GDS) as a new agency and inclusion of cadastral survey and land title records.

> This would remove a core mission from land management agencies. BLM's authority for public land surveys and records and the development of the ALMRS dictate that we assume a leadership role for maintenance of the land records. The findings and recommendations in the report show little understanding of the relationship between survey and title records with land management functions. As proposed, the GDS would create an additional step by requiring land managers to petition another bureau for information needed on a day to day basis. We intend to increase our coordination of land records functions to take advantage of technologies that will facilitate information exchange and help avoid duplication.

Again thank you for the opportunity to comment on this draft report.

Sincerely,

Director



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

In Reply Refer To:
Mail Stop 590

NOV 0 3 1997

Mr. Roger Sperry
National Academy of Public Administration
1120 G Street NW, Suite 850
Washington, DC 20005-3821

Dear Roger:

This letter is in response to your request to the Executive Secretariat of the Federal Geographic Data Committee for review of the draft National Academy of Public Administration Study of US Geographic Data Resources. In keeping with your request, additional review was not obtained from FGDC representatives. This review and letter thus reflects the views of the Executive Secretariat only, and does not necessarily reflect the views of individual FGDC Agencies. The four federal agencies which sponsored the study are members of the FGDC and are providing comments to you, but the remaining FGDC agencies have not commented on the draft report.

The NAPA Study Panel and Team have done a commendable job in addressing an extremely complex subject and have provided a set of recommendations that should aid in continuing the progress already underway to improve the management and use of geographic information resources in the United States. The recommendations and accompanying findings and conclusions which are in the final report will be carefully reviewed by the Federal Geographic Data Committee. Our intent is to use those which are relevant to the National Spatial Data Infrastructure and the FGDC to help meet the enormous challenges ahead in developing the NSDI. Some of the recommendations may not be feasible for implementation, but we will still carefully examine their intent and seek to determine if there will be public benefit from alternative approaches.

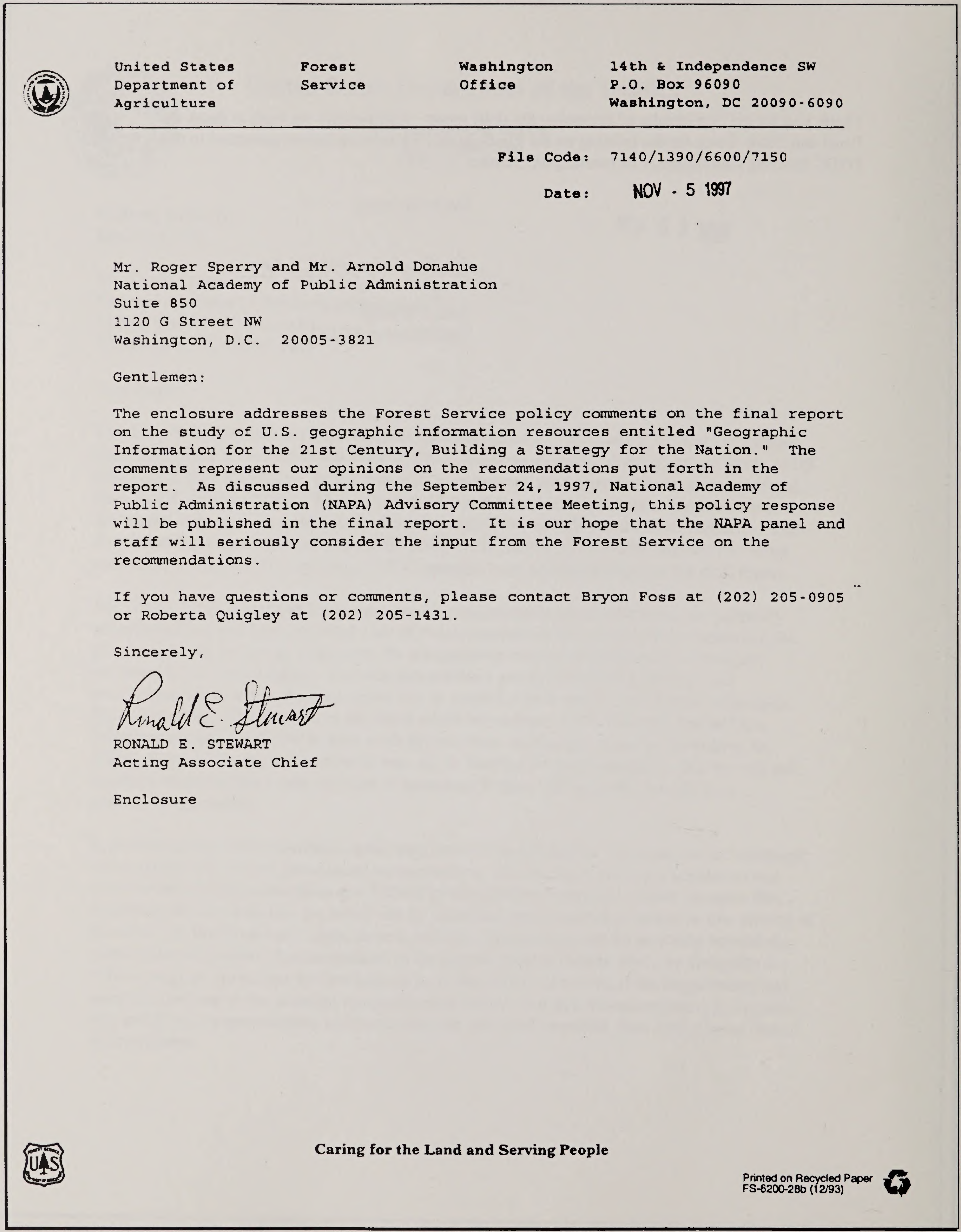
In particular, two recommendation areas may prove to be infeasible. These are the development of legislation and federal government reorganization. As you know both new legislation and government reorganization plans are difficult to effectively accomplish. While we agree that legislation for activities like the NSDI can be beneficial, such legislation would be low priority at this time. As the Draft report says, there is still not a compelling case for anything beyond the current executive order. Reorganization of the federal structure would likely be disruptive to critical program operations that are helping build the NSDI. However, if the Departments and agencies involved in the potential reorganizations believe that this recommendation is a positive step and if new responsibilities will have adequate resources provided, then such a move should be considered.

Thank you for the opportunity of reviewing the draft report. Additionally we wish to thank the Panel and Study Team for the briefing on the Findings and Recommendations presented to the FGDC Steering Committee at its meeting on October 22, 1997.

Sincerely yours,

John J. Moeller

John J. Moeller
Staff Director, FGDC



United States Department of Agriculture
Forest Service
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Washington, DC 20090-6090

File Code: 7140/1390/6600/7150

Date: NOV - 5 1997

Mr. Roger Sperry and Mr. Arnold Donahue
National Academy of Public Administration
Suite 850
1120 G Street NW
Washington, D.C. 20005-3821

Gentlemen:

The enclosure addresses the Forest Service policy comments on the final report on the study of U.S. geographic information resources entitled "Geographic Information for the 21st Century, Building a Strategy for the Nation." The comments represent our opinions on the recommendations put forth in the report. As discussed during the September 24, 1997, National Academy of Public Administration (NAPA) Advisory Committee Meeting, this policy response will be published in the final report. It is our hope that the NAPA panel and staff will seriously consider the input from the Forest Service on the recommendations.

If you have questions or comments, please contact Bryon Foss at (202) 205-0905 or Roberta Quigley at (202) 205-1431.

Sincerely,

Ronald E. Stewart

RONALD E. STEWART
Acting Associate Chief

Enclosure

Caring for the Land and Serving People

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The following comments are in response to recommendations made by the National Academy of Public Administration (NAPA) study of U.S. geographic information resources entitled "Geographic Information for the 21st Century, Building a Strategy for the Nation."

NAPA Recommendation: **Draft a new statute, in cooperation with state, local and other organizations, to create a National Spatial Data Infrastructure (NSDI) and better define federal agency roles and responsibilities for NSDI and to meet their own programmatic needs.**

As proposed, the new statute would include, at a minimum:

1 - A list of congressional findings about geographic information.

2 - A statement of national goals and definition for the NSDI.

3 - A charter for the National Spatial Data Council (NSDC).

4 - Consolidation of federal base geographic information functions (Geographic Data Service).

5 - Modifications to existing law to facilitate geographic information partnerships, Cooperative Research and Development Agreements (CRADA) , and private-sector procurements.

6 - Amendments or recisions of current law to modernize and conform existing program authorizations to the NSDI concept.

The Forest Service (FS) supports the national goals set for the NSDI and also supports any legislation that could help advance the concept of a fully functional NSDI. However, the newly proposed legislation should not detract in any way from land management agencies abilities to achieve their program requirements. Any amendments or recisions of current laws to change program authorizations to be more supportive of the NSDI concept should enable land management agencies to carry on their missions without imposing "unfunded mandates" or by coupling unattainable performance measures to NSDI goals and objectives. We agree that the federal agencies need to incorporate geographic information and geographic information systems, and the NSDI concept into overall information technology strategies and plans. We also agree that increasing U.S. Geological Survey (USGS) staff support for Federal Geographic Data Committee (FGDC) Secretariat functions and dedicating staff in each agency for standards development, implementation, compliance and outreach, especially to federal field offices, is needed to accomplish the goals of NSDI. However, additional funding from Congress will be needed in order to successfully accomplish the tasks specified in the report.

The Forest Service does not support the creation of a new bureaucracy, the NSDC, to address the geospatial needs of the country. However, the FS does agree that amending the Federal Advisory Committee Act in order to facilitate expanding membership in the existing FGDC to include state, county, local communities, tribal governments and the private sector is necessary to support the needs of the entire geospatial community. We believe the goals and objectives outlined for the proposed NSDC are obtainable by altering the charter and mission of the FGDC. This could include an option to program additional Congressional funds to FGDC to assist agencies with implementation of FGDC standards. The proposed model for the new NSDC does not allow for the membership of federal employees on the Board of Directors, yet offers this opportunity to other non-federal member organizations and individuals. This model would not allow adequate representation from the federal government which plays a key role in the geospatial community. We are concerned that the organization recommended to manage the geospatial requirements for the United States is planned to be located in the private sector. The organization should be managed to support the geospatial needs of the country and not be driven by profit. We concur with the following recommendations that support enhancing the authority and mission of the FGDC:

- Appoint an OMB Program Associate Director for Natural Resources, Energy and Science and a Senior Staff member from the Office of Science and Technology Policy as full members of FGDC in order to reconcile conflicts and to monitor agency implementation.

- Encourage stronger involvement by state, local, and tribal government participation in the FGDC and FULL INVOLVEMENT by the private sector.

- Encourage active participation in the FGDC by the National Aeronautic and Space Administration and the Department of Defense and all agencies having major geographic information programs.

- Increase implementation of the current FGDC clearinghouse by (1) identifying as much geospatial data as possible from all sources; and (2) evolving toward user-friendly, on-line data access.

- Increase visibility of the value of NSDI with Congress, state legislatures, county commissions, city councils, professional association, commercial and the public.

NAPA Recommendation: **Develop a reorganization plan in cooperation with the proposed National Spatial Data Council, to implement the Geographic Data Service (GDS) and realign the federal field structure for base geographic information.**

The FS is opposed to the creation of a "new" federal agency, such as the GDS. We are troubled that NAPA would propose organizational changes without clear and convincing evidence that such reorganizations are needed or beneficial. For example, the report attempted to demonstrate duplication in the federal surveying community with a map and table highlighting the distribution of federal land surveyors employed by four of the largest land management agencies. In reality, what this map and table demonstrated is the number and distribution of land surveying positions needed to meet federal land surveying needs of the four represented federal agencies. The federal agencies do not fund positions and organizations, they fund land and resource management needs which dictate the number and distribution of federal land surveyors.

The FS is skeptical that the proposed GDS would have the capability of absorbing all federal government geographic information requirements. The tangible and intangible costs have not been considered or addressed anywhere in the report. In addition, the FS established and funded the Geometronics Service Center to address the needs of the FS for base geographic information because the U.S. Geological Survey/National Mapping Division was unable to meet those needs in a timely manner. This was also true in the FS surveying community. Funds provided to the Bureau of Land Management (BLM) for the cadastral program have diminished because BLM was unable to provide the required cadastral survey information in a timely manner.

The enactment of the proposed statute to strengthen the FGDC would help facilitate many of the goals and objectives set for building a more robust NSDI, in lieu of creating the GDS. While a consolidation of Federal geospatial functions may accelerate the implementation of a robust NSDI, the needs of agencies for time-critical information to adequately respond to situations such as fire and forest health must be fully considered. The FS and other agencies with focused, resource management-based missions must have the latitude to perform their missions without dealing with an "oversight agency" which is not responsible or accountable for the needs of the land and resource management agencies. Throughout the course of the study, the FS has clearly stated how surveying and base geographic information is used to support resource management "on the ground" and that in our activities we strive to promote data sharing and partnerships. Another federal agency is not needed when the proposed duties of the GDS, acting in a coordination role, could be delegated to a refocused FGDC.

NAPA Recommendation: Create a performance-based organization (PBO) in the Department of the Interior for the federal surveying and land title records activities.

The FS is opposed to any reorganization or consolidation of federal surveying and land title records which would remove these critical assets from direct management and supervision of FS land managers. NAPA has not provided data or sufficient facts to support their opinion that consolidation of all federal surveying activities is needed or would be effective or cost efficient. The NAPA report does not document duplication of efforts, resources, or mission objectives to support their proposed consolidation. NAPA did not document or prepare a study or evaluation which looked into the effects that the proposed consolidation would have on the ability of the land management agencies to meet the mission of their agency.

If the recommendation to proceed with the PBO is adopted, the PBO should be located outside of the BLM or any other existing single federal agency. The creation of a new agency would more easily contribute to a mission-specific need focused on the requirements of all agencies. This would also help eliminate any past misunderstandings between surveying organizations concerning issues such as survey authority. In addition, the PBO should allow the federal agencies to retain sufficient land surveying work force and capability within the individual federal agencies to meet critical and day-to-day land surveying needs. These include some land surveys, survey opinions, land descriptions, trespass and title claims, and general land surveying questions. Removing survey capability and federal land title records from the local land manager may result in the FS responding to pressing surveying and land title needs without utilizing state licensed professionals.

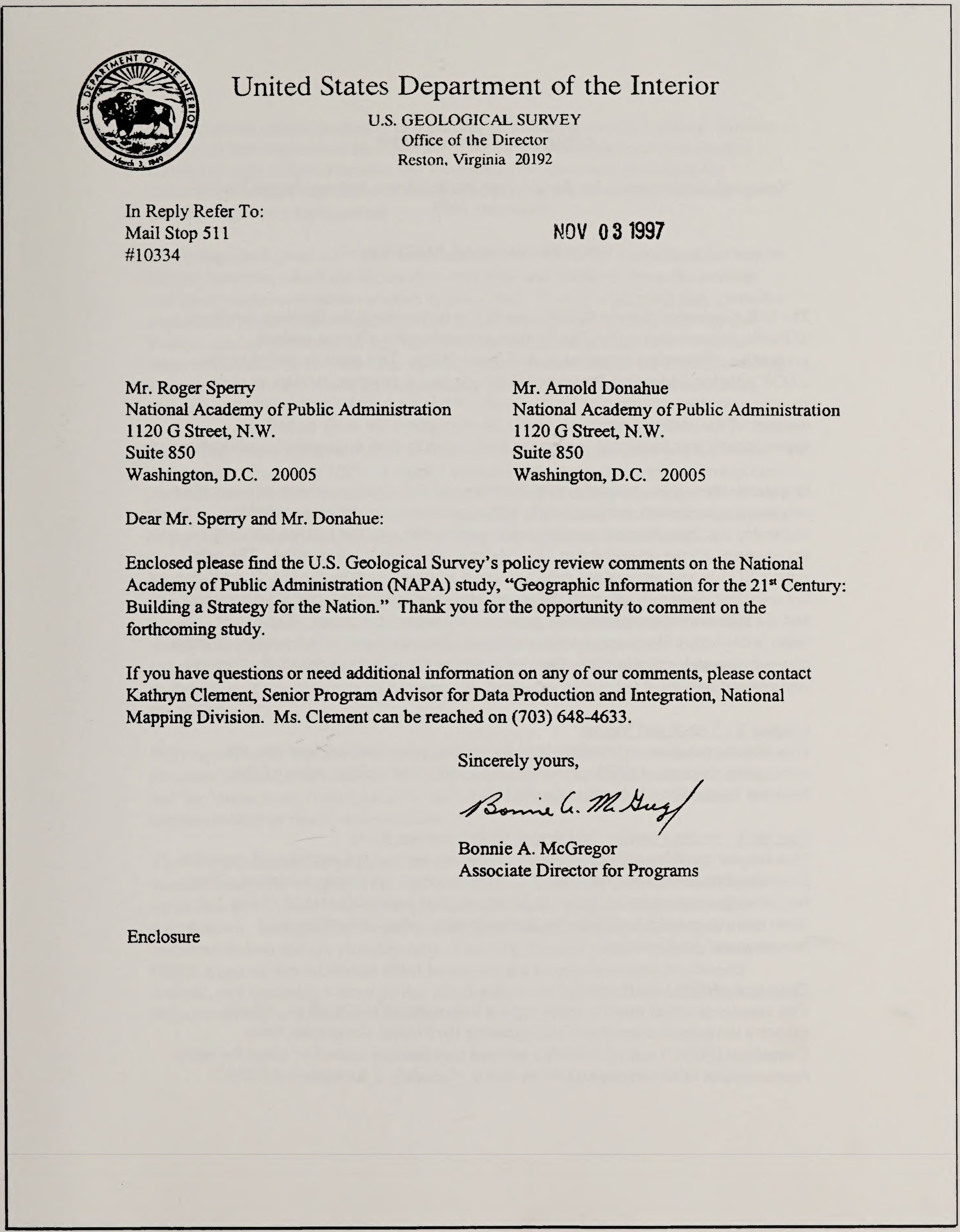
NAPA Recommendation: **Government agencies should avoid engaging in value-added activities beyond the research and development phase when they be can provided by the private sector at or near government cost.**

The Forest Service disagrees with the term "value-added" used in this context. Supported by law, (CFR, Title 36, Section 295.4 and CFR, Title 36, Section 212.20(a)) the FS has determined that the responsibility and accountability for content and quality of information provided on base geographic and derivative products is "inherently governmental." Base geographic and derivative products provide the public with information concerning "on-the-ground" activities that control accessibility to the national forests.

NAPA Recommendation: **USGS or the GDS should be tasked to coordinate federal acquisition of imagery from all sources, including aerial, classified intelligence, civil domestic and foreign and commercial satellite imagery.**

The FS agrees that the acquisition of satellite imagery is best coordinated from one point of contact. However, problems arise after the procurement of the imagery has been completed. Data sharing rights are limited by the licensing regulations that are imposed by the contractor supplying the information. These regulations inhibit data sharing opportunities for any organization that wants to acquire the information in a cost effective manner.

The FS strongly disagrees with the recommendation for all other imagery types to be coordinated by one point of contact. The FS is required to procure aerial photography from the USDA Aerial Photography Field Office (APFO) for the acquisition of resource aerial photography. APFO provides good customer service to the FS in meeting aerial photography requirements. The FS also utilizes in-service aircraft to fly aerial photography that supports time-critical resource management activities requiring immediate response. Fire mapping and other events that may endanger the forests need immediate action and require this in-service capability to respond to these critical demands.



March 3, 1849

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Office of the Director
Reston, Virginia 20192

In Reply Refer To:
Mail Stop 511
#10334

NOV 03 1997

Mr. Roger Sperry
National Academy of Public Administration
1120 G Street, N.W.
Suite 850
Washington, D.C. 20005

Mr. Arnold Donahue
National Academy of Public Administration
1120 G Street, N.W.
Suite 850
Washington, D.C. 20005

Dear Mr. Sperry and Mr. Donahue:

Enclosed please find the U.S. Geological Survey's policy review comments on the National Academy of Public Administration (NAPA) study, "Geographic Information for the 21st Century: Building a Strategy for the Nation." Thank you for the opportunity to comment on the forthcoming study.

If you have questions or need additional information on any of our comments, please contact Kathryn Clement, Senior Program Advisor for Data Production and Integration, National Mapping Division. Ms. Clement can be reached on (703) 648-4633.

Sincerely yours,

Bonnie A. McGreg

Bonnie A. McGregor
Associate Director for Programs

Enclosure

AGENCY POLICY REVIEW

"Geographic Information for the 21st Century: Building a Strategy for the Nation"
November 1997

U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey (USGS) would like to commend the National Academy of Public Administration (NAPA) for their comprehensive effort to analyze geographic information resources in the United States. This study is critical to the USGS's National Mapping Program (NMP) and to our program partners as we position ourselves strategically for the future. While we have been very active as a member of the advisory committee to NAPA throughout the study period, we appreciate the opportunity to review the total report in draft form prior to publication.

In general, the report provides a very complete and thoughtful overview of the study origins, geographic information trends, public purpose roles and responsibilities, leadership and coordination, structure and organization, and the balance between government and the private sector as it relates to geographic information. The only areas USGS would recommend need additional editorial work by the NAPA staff are the organization and structure of the report itself, particularly the executive summary, and the inclusion of implementation guidance throughout the report. The report, when published, will serve as a very useful and informative resource for many different communities and organizations. Our comments on the individual report chapters are summarized below:

Chapter 2 - Trends and Vision
This chapter serves as an excellent base for guiding principles that lead into the subsequent chapters. USGS agrees with the trends cited and the vision of the National Spatial Data Infrastructure (NSDI).

Chapter 3 - Public Purpose and Geographic Information Roles
This chapter provides solid background on existing roles of the sectors with regard to particular data themes and on roles of government agencies based on mission. The recommendations appear to be broad statements that support the NSDI vision, but serve more as guiding principles for agency strategic plans rather than true recommendations for action.

Chapter 4 - NSDI Leadership
This chapter provides positive support for a truly national NSDI effort. USGS supports the general concepts of strengthening the Federal Geographic Data Committee (FGDC) and of creating a national coordinating council to allow for equal representation of all components of the NSDI. Certainly, a strengthened FGDC

would provide critical leadership to a national coordinating council's efforts. Further, the USGS fully agrees that the influence of the Office of Management and Budget (OMB) and the Office of Science and Technology Policy would strengthen the political and budget base of the FGDC membership as well as serve to improve executive agency's participation.

The background given on FGDC in this section understates the institutional barriers in Federal agencies, where the trickle-down of policy and standards from the steering and coordination committees is often dysfunctional. Also, it is puzzling that, given the explanation in this section relative to the restrictions imposed on the FGDC by the Federal Advisory Committee Act, that no recommendation is made to either relax these restrictions, or provide other options. Recommendations to the FGDC to more actively involve non-Federal entities certainly cannot be implemented without such action.

The USGS encourages the NAPA to consider strengthening the notion of the utility and benefit of including NSDI in agency strategic plans in response to the Government Performance and Results Act (GPRA) legislation, and in calling for support from OMB to make this happen. As OMB is essentially the "parent" of Circular A-16 and of the FGDC, this is a logical step for creating a strengthened basis for NSDI.

Chapter 5 - Organization and Structure
The USGS recognizes that statutory authority for NSDI-like activities can be beneficial. However, recognizing the obvious risks to the existing basis for NSDI by simply moving forward with a recommendation for new legislation, the USGS suggests that a more immediate action could be a review of the existing statutory base to determine if this objective could be met by better use of existing legislation such as the GPRA.

With regard to the transfer of the National Geodetic Service (NGS) to the USGS; we recommend that further analysis be jointly conducted by the Department of Commerce and the Department of the Interior to determine the most effective and efficient implementation of this recommendation.

The USGS endorses the goals and objectives that would be achieved by the establishment of a Geographic Data Service (GDS); however, we believe that these could also be met with innovative approaches to logical program alignment and coordination. Recognizing the political reality of actually accomplishing such a recommendation and the potential risks of moving forward with a reorganization, the USGS suggests that additional effort be put toward a comprehensive cost/benefit analysis, and designing a strategy that could realize the GDS goals and objectives before resorting to a physical consolidation.

Chapter 6 - Balancing Roles and Functions
The USGS strongly agrees with the analyses and recommendations in this Chapter. The establishment of State and local geographic information coordinating groups or focal points will surely enhance coordination and cooperation among all governmental sectors to benefit the NSDI. In addition, the USGS supports the recommendations to enhance the coordination of Federal imagery and remote sensing acquisition, utility, and access. Further, the report recommendations that government agencies should avoid engaging in value-added activities when they can be provided by the private sector at or near government cost and that outsourcing decisions should be made on the basis of the respective roles, responsibilities, and competencies of the governmental and private sectors is consistent with USGS policy.

Chapter 7 - Other Analyses
The USGS concurs with the analyses and recommendations in this Chapter. There is certainly a need for closer coordination of technology development and procurement programs as they relate to the development, application, and management of geographic information. The USGS also recognizes the need for closer involvement of the National Imagery and Mapping Agency and the National Aeronautics and Space Administration in the FGDC standards and coordination activities.

Again, the USGS appreciates the opportunity to review and comment on this important and comprehensive study. This study provides a critical starting point for policymakers and the profession as a whole to consider further and to work together to implement.

COMMENTS OF NOAA'S NATIONAL OCEAN SERVICE
ON THE
DRAFT REPORT OF THE NATIONAL ACADEMY OF PUBLIC ADMINISTRATION
ON THE
FUTURE OF GEOGRAPHIC INFORMATION

October 31, 1997

THE NATIONAL OCEAN SERVICE

This commentary was provided by the National Ocean Service in response to an earlier draft of this NAPA report. The reader is advised that the *final* report to which this response is attached may have been edited after this response was provided.

The National Ocean Service (NOS) is one of the five major line offices of the National Oceanic and Atmospheric Administration in the Department of Commerce. NOS was one of the four federal agencies that provided direct support for this study. This commentary does not include the views of other NOAA offices, some of which regularly acquire, utilize, analyze, and disseminate geographic information as part of their operations, including the National Weather Service, the National Environmental Satellite Data and Information Service, the National Marine Fisheries Service, and the Office of Oceanic and Atmospheric Research. It also does not include the views of other agencies within the Commerce Department, including the Census Bureau and the National Institute of Standards and Technology.

Four separate NOS programs with programmatic interests in GI provided input into this response. They are the Office of the National Geodetic Survey (NGS), the Office of the Coast Survey (CS), the Coastal Services Center (CSC), and the Office of Aeronautical Charting and Cartography (ACC).

The NAPA report resulted in numerous findings and conclusions and more than 50 recommendations. NOS concurs with many of these, but in the interest of keeping this response as succinct as possible, NOS will not comment on all areas of agreement. NOS also will not provide views on every area with which it may not concur. Instead, this response is intended to address the significant conclusions and recommendations which NOS believes should be implemented or which require further review and analysis.

OVERVIEW

The National Ocean Service commends the staff and panel of the National Academy of Publication Administration for their efforts in producing this analysis on the present and future direction of geographic information (GI). This study is a significant step in the ongoing dialogue on how best to administer federal GI programs and to develop a more coherent and accessible National Spatial Data Infrastructure (NSDI). The panel and staff faced a daunting and complex task and did a remarkable job of raising and highlighting many of today's major policy and technical issues. NAPA recognized that rapidly advancing technological changes will continue to revolutionize how geographic data is acquired, maintained, and disseminated. The resulting study provides a thoughtful analysis of the significance of GI to the nation's present and future economic and environmental well being.

However, it also seems that in an attempt to address such a wide range of issues the study lost some of its focus. It is unclear why certain topics were discussed in detail while others were given only brief mention. The study purports to provide a comprehensive discussion to meeting the nation's spatial data needs yet at times it fails to adequately address or document significant GI programs. The findings, conclusions, and recommendations are not prioritized and it is at times difficult to determine what actions are fundamental to improving the spatial data infrastructure of the nation. For example, only about 20 of the 50 recommendations are listed in the Executive Summary, but there is no confirmation that those 20 recommendations are more significant than the others. Finally, at times the study reaches conclusions without supplying a clear factual basis; while at other times facts are presented but no conclusions are reached.

This response will address two of the study's major recommendations that are aimed at spurring a more rapid development of a robust NSDI: 1) the creation of a National Spatial Data Council (NSDC); and 2) the creation of a Geographic Data Service (GDS), including the transfer of NGS from NOS to the United States Geological Survey (USGS) as an interim step to creating the GDS. In addition, this response will address the need to better quantify and document the costs and benefits associated with implementing many of the studies recommendations, and the need for a more complete analysis of public and private roles in the future of GI.

THE NATIONAL SPATIAL DATA COUNCIL

The study concludes that there is a need to more rapidly advance and improve the country's National Spatial Data Infrastructure. To help achieve this objective, the study recommends that legislation be drafted and passed authorizing the creation of the National Spatial Data Council. In theory, this council would bring all interested parties (federal, state, local, private, academic, and non-governmental) to the table with the specific goal of fostering a more robust NSDI. The NSDC would be a non-profit organization authorized by the Congress but clearly located in the private sector. It's duties would complement those of the Federal Geographic Data Committee (FGDC), leaving the FGDC to concentrate on coordinating federal GI functions. Membership on the NSDC would be open to all organizations and individuals in return for payment of dues. Dues would vary and different classes of membership would be created with sustaining and contributing organizations being charged higher fees. Initial funding might come from a three-year federal grant. In some cases, the NSDC would either assume or complement the responsibilities of other organizations, including the FGDC.

The study states that this proposed model for the NSDC is based on existing institutions. The National Institute for Building Sciences and ITS America are offered as models for the NSDC. However, the study does not discuss if those institutions are considered successes, and it also does not make clear why or if they provide appropriate models for the specific task at hand -- improving the NSDI.

Many questions about this new organization are left unanswered. Chief among these are its relationship to the FGDC which the study states has made significant strides to improve the coordination of GI. Some specific concerns and areas in need of further analysis include:

- Whether the creation of the NSDC will create another layer of bureaucracy which may delay, rather than enhance, the development of a more robust NSDI;
- Whether creation of the NSDC will only add confusion and weaken the efforts of the FGDC;
- Whether exemption from the Federal Advisory Committee Act (FACA) for the FGDC might spur similar, and perhaps even more equitable, results; especially for state and local governments most in need of advancing their GI infrastructure; and
- Whether the recommended financing system for the proposed NSDC will favor larger, better established public and private GI interests at the expense of other interests.

The focus of this study is primarily on the future public policy direction for federally-funded GI activities. While the study supports outsourcing for certain functions, the full privatization of federal GI programs specifically was not recommended. This is because full privatization means government funding would no longer be provided for the acquisition, production, or dissemination of the privatized GI function. Because the private sector requires profit, privatization is only feasible for commercially viable GI services. But, much GI is not commercially viable because in most cases the only or primary customers are governmental. Because most GI is publicly funded and primarily serves public purposes, it is unclear why the proposed NSDC should be located in the private sector. Private sector GI organizations have demonstrated ample ability to organize themselves in pursuit of their common interests.

NOS is concerned that the proposed financing/membership arrangement for the NSDC will favor large, private sector interests and will stifle the development of innovative, smaller private GI firms. In addition, poorer state and local governments, which may be most in need of advancing their GI infrastructure, may not be able to afford to actively participate on the NSDC. Such risks run counter to the goal of promoting free and open access that is fundamental to a robust NSDI. An NSDC dominated by a limited number of well-to-do private and public interests will result in a piecemeal and inequitable NSDI lacking a truly "national" scope. This would run counter to the goal of implementing an NSDI that furthers public participation in the democratic process. In a worst case scenario, the proposed NSDC would only politicize important public GI policy concerns and usurp legislative and administrative authority over predominantly publicly-funded GI programs.

In several places, the study recognizes that strong federal leadership is a prerequisite to creating a free, accessible, and robust NSDI that promotes democratic principles, is national in scope, and that provides equitable benefits to all regions of the country. It is therefore unclear why there is a need to supersede the FGDC and compromise the efforts of this relatively new federal organization. The FGDC has been charged with implementing the NSDI and has made significant strides in doing so. Therefore, NOS supports the study's recommendations that are aimed at bolstering the capabilities of the FGDC.

The National Ocean Service has been an active participant and supporter of the FGDC. The FGDC does have weaknesses, but the creation of a new organization is not the solution. Despite a lack of funding and support for the FGDC, the study chronicles the many successes of the FGDC since it was created in 1990. The FGDC has only had its own budget since 1994 and efforts to further strengthen the FGDC are a logical and reasonable next step. This effort should include either legislative or executive action--

- Either complying with or getting an exemption to the Federal Advisory Committee Act to enable increased state and local participation on the FGDC;
- Providing increased funding for the FGDC, including grant funding to promote more state and local participation on the FGDC and to support outreach to state and regional GI committees;
- Diversifying and increasing the staff of the FGDC by creating a rotation system that would place staff from state, local and federal agencies as detailees on assignment to the FGDC;
- Considering legislation or administrative orders that require increased participation on and support for the FGDC by federal agencies involved in GI; and
- Requiring that OMB take a more active role in overseeing, evaluating and coordinating federal GI activities, including the more active participation of OMB on the FGDC as recommended in the study.

THE GEOGRAPHIC DATA SERVICE

At first glance, it appears natural that the creation of a more robust NSDI might be advanced by consolidating some or all federal GI activities into a single organization. However, a prerequisite to creating such an organization should at a minimum include providing a full inventory and description of all federal GI programs and their costs. With a few exceptions, including some analysis of Department of Defense applications of GI and the Census Bureau's TIGER files, the study's focus is limited to the programs of the four sponsoring agencies. This amounts to a minority of the estimated 30 federal agencies and programs that are actively involved with GI. The study therefore does not provide a comprehensive analysis of federal programs that might be best suited for inclusion in the GDS and which may not.

One rationale given in support of the GDS is the "critical mass" argument, i.e., if you get enough programs under the same roof something dynamic will occur. The critical mass view is, of course, not new. It also has serious flaws and is considered outdated by many experts in public administration. The many technological advances in communications that are mentioned in the study further diminish consolidation and centralization as appropriate management tools for the 21st Century. A distributed, well coordinated NSDI with each "node" of the infrastructure specializing in its unique aspect of GI will be more effective because it will continue to allow GI programs to remain linked to their important public policy missions while at the same time requiring their feedback into the NSDI. It is this diversity of applications and uses of GI that will help ensure a robust and relevant NSDI. A distributed presence also would tend to infuse the NSDI philosophy and culture throughout government instead of centralizing it in one department. The key to a successful spatial data infrastructure is in the strength of the network, i.e., the technological roads, bridges and way stations that link the various pieces together. Improving that infrastructure is the task of the FGDC and its regional, state, and local counterparts, as was mentioned earlier in this response.

NOS supports the recommendation to better coordinate the field office structure to improve coordination of federal GI programs with state and local GI interests, however, it is not clear that formal consolidation of federal programs is a prerequisite to achieving this goal.

The study also does not provide a detailed analysis of existing relationships and interdependencies between federal GI programs and other federal, state, and local programs and GI needs. Specifically, the study does not chronicle the natural flow of different types of GI data from acquisition to application. This results in some apparent inconsistencies. For example, just over a year ago a different NAPA report on NOS's National Geodetic Survey and Coast Survey recommended these programs be moved, not to Interior, but to the Department of Transportation (DOT). But, while this study supports the transfer of the Office of Aeronautical Charting and Cartography to DOT, it recommends the transfer of NGS to Interior while leaving open the possibility that the Coast Survey could remain at NOS in the Commerce Department. It is unclear why disestablishing the long-standing and well-documented synergies among some GI programs is promoted, while other GI activities having few demonstrated synergies are recommended for consolidation.

It is true that the report, while promoting a GDS, does not explicitly endorse a single model for its organization. The study calls for creation of a task force by OMB under the auspices of the FGDC to work out the details of the GDS before submitting a formal plan to the Congress for approval. NOS concurs with this approach and believes more analysis, especially a formal cost/benefit analysis, is required prior to disrupting ongoing GI activities with costly and time-consuming transfers. However, despite its call for additional analysis, the study recommends the immediate transfer of NGS from NOS to USGS. NOS specifically concludes that the study prematurely recommends the transfer of NGS to USGS; and prematurely recommends that NGS, and possibly the Coast Survey, be considered candidates for inclusion in the GDS.

The study states that reasons justifying consolidation of certain GI functions include elimination of redundancies, improved performance, and/or reduced costs. However, no evidence is presented that the transfer of NGS would achieve any of these objectives. On the contrary, the work of NGS is not redundant of the GI efforts of other agencies. Furthermore, the study calls NGS a "solid performer", and suggests that funding, not location, is the primary obstacle. There is no evidence that funding for NGS would increase if moved to USGS.

Other concerns regarding the recommended transfer of NGS to USGS include --

- that the future of geodesy is in positioning things that move, i.e., the future of NGS is more relevant to commerce and transportation than the mission of USGS. The study itself confirms that under NGS's state geodetic state advisor program the advisors are usually located in the transportation departments of participating states.
- that among all of the individuals and organizations that were interviewed the study cites none of them as recommending this transfer;
- that NGS constituencies and product users have not recommended such a transfer
- that there is no cost/benefit analysis justifying the move;
- that there are no apparent savings;
- that there is no evidence that the NSDI will be furthered or that services will be improved by the move;
- that the USGS has never articulated how its programs would benefit by adding NGS;
- that much of USGS's mission involves small-scale topographic mapping which does not fully utilize or appreciate the significance of geodesy, especially for precise positioning applications that are vital for charting and navigation; and
- that the study does not fully consider that NGS works regularly with other NOAA programs such as the Forecast Systems Lab, oil spill response in Hazmat, tidal predictions, nautical charting, and coastal and fisheries management.

THE NEED FOR A MORE DETAILED COST/BENEFIT ANALYSIS

It is understandable that in today's budget-balancing climate it may be difficult to persuade policy makers to commit significant new resources for GI and the NSDI. However, this does not obviate the fact that implementing a robust NSDI will require additional investment. The study recognizes this early when it notes that one of the significant steps toward implementing the NSDI was when the FGDC finally received its own budget authority in 1994. Although the study mentions the need for investment in the NSDI on several occasions, it fails to articulate an estimate of the costs or benefits of this investment.

Most disturbing is the suggestion early in Chapter 2 that in this era of government frugality the resources available to further the standards and procedures necessary to implement a robust NSDI must largely come from within and not as add-ons. This implies that the NSDI is to be built out of the base budgets of existing GI programs. NOS does not oppose requiring GI programs to increase their support for the NSDI, however, congressional approval probably will be required. For example, congressional authorizers and appropriators who have supported recent increases to address critical nautical charting backlogs may not appreciate having their hard-fought-for increases being spent instead on implementing the NSDI.

Ultimately, a robust NSDI is not likely to be implemented by such back door methods anyway. At some point, direct congressional and administrative support for the NSDI must be sought and won. If the panel in fact concluded that the NSDI represents an important national policy objective, then this study should have provided a justification for the necessary investment. The study does a good job of chronicling the importance of the NSDI. Many sectors of the nation's economy rely upon GI. Resource management and environmental programs are wholly dependent on access to quality GI. This study should have shed more light on the costs to implement a robust NSDI and the benefits it would provide.

The study does provide one table (2-1) indicating sectors of the economy that are dependent upon GI, however, it is unclear how authoritative the numbers are. As an initial step, it would be helpful if the study clearly documented the annual public investment (federal, state, and local) in GI and provided a clearer estimate of the benefits this investment provides the nation. The study's statement that such an assessment is either not necessary or difficult to conduct is unsupported.

THE NEED FOR A MORE COMPLETE ANALYSIS OF PUBLIC AND PRIVATE ROLES

One of the principle purposes of the study was to provide guidance as to the roles of the public and private sectors in providing the nation's GI infrastructure. Two of the four questions posed to the panel stemmed from the underlying issue of the proper federal role vis-a-vis nonfederal and private interests. The study makes several recommendations in Chapter 6 and elsewhere with which NOS concurs, including that in most instances the private sector should be a primary source of value-added products and services; that outsourcing should be based on responsibilities, competency, and cost effectiveness; that arbitrary percentages for outsourcing should be avoided; that multilateral partnerships and Cooperative Research and Development Agreements should be more fully exploited; and that open access should be maintained to data used in public policy decision-making.

The study also suggests, but does not conclude, that outsourcing for aeronautical and nautical charting may warrant a more cautious approach to outsourcing because the government retains liability for the accuracy of these products upon which the public and industry regularly rely for safe navigation. NOS would add that in addition to the liability concern, the inherently governmental and overriding public safety mission of these charting programs is an equally important factor. Combined, these factors explain the study's finding of a lower level of outsourcing for these programs. At this time, it does appear these concerns are being resolved. NOS has promoted utilizing a balanced national capacity that for the next decade would employ a mix of NOAA's remaining hydrographic ships, contracting for data, and longer-term leasing of vessels and ship services. NOS expects that more than 50 percent of its hydrographic data will be acquired through outsourcing by FY 1999.

In many instances, however, the study's findings regarding public and private roles are rather general. For example, the study states that "division between inherently governmental and private sector activities is changing, will continue to shift, and is best settled by consensus agreement,..." (ES-4.) Such an observation falls short and adds little to resolving the complex issues involved in determining governmental and nongovernmental roles. Critical to this discussion is understanding who pays for GI and who has rights to the data. The study, however, does not present facts regarding what percentage of GI is funded by governments (federal, state, and local) and what percentage is purely privately funded.

In other instances, the study concludes that maintaining free and open access to GI is paramount in a democratic society. However, at the same time the study supports the expansion of private sector involvement in public GI and the protection of private intellectual property rights. There is a tension between these objectives that is left unresolved. The study recognizes this tension and even states this issue "demands attention and resolution." (2-3.) Yet the study neither gives the issue the attention it demands, nor offers options for resolution. This is especially troublesome because the study foresees that the private sector role will only increase in the future. How useful or robust will the NSDI be if free and open access is limited because of private intellectual property rights protection for GI data? Finally, the study provides scant assistance for determining when the government is "unfairly competing" with the private sector and when the government is legitimately pursuing the public interest.

CONCLUSION

The NAPA study compiles a great deal of information about GI and this report should serve as resource for GI policy makers for many years. However, this compilation also resulted in a compendium of information that often lacks clear direction and focus. There are many assumptions and findings that are not clearly based upon an objective analysis of data or a thorough inventory of ongoing activities. With more than 50 recommendations, it is difficult to determine if some are essential and if some are more critical than others. The failure to subject the findings, conclusions and recommendations to cost/benefit analysis is fatal, and the failure to identify an "advocate" or champion may result in an inability to pursue the proposed recommendations.

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